NAVAL FIGHTERS NUMBER FORTY-EIGHT

Kaiser Fleetwings

XBTK-1

BY BOB KOWALSKI

INTRODUCTION

Bob Kowalski continues the saga of the Bomber Torpedo (BT) program and the similar Scout Bomber (SB) program with the obscure story of the Kaiser Fleetwings XBTK-1. The story started in Naval Fighters Number Twenty-Four, Martin AM-1/-1Q Mauler and continued with Naval Fighters Number Thirty, Douglas XSB2D-1 and BTD-1 "Destroyer". This was followed by Naval Fighters Number Thirty-Six, Douglas XTB2D-1 Skypirate and now the XBTK-1. It is our intention to also cover the two Curtiss entrants, the XBTC-2 and XBT2C-1.

This history is based on information contained in the 1944 Detail Specification SD-367 and addendum number one which was supplemented with Naval Air Test Center BIS Report 2180.1 (9 September 1946 - 2 June 1947) and flight and maintenance manuals. Terms used in the story are terms used at the time the XTBK-1 was built. These terms may have subsequently undergone refinement, for example the term "heat" instead of the "thermal" anti-icing system.

Anyone having photos or other information on this, or any other naval or marine aircraft, may submit them for possible inclusion in future issues. Any material submitted will become the property of NAVAL FIGHTERS unless prior arrangement is made. Individuals are responsible for security clearance of any material before submission.

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Steve Ginter, 1754 Warfield Cir., Simi Valley, California, 93063

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Authors note: Any important study of the XBTK-1 has to include the political ramifications attached to the name Kaiser. Henry J. Kaiser was an industrialist known to be a favorite of the Roosevelt administration. His World War Two enterprises are best remembered for his construction of 821 Liberty Ships and 50 escort carriers of the Casablanca class. However, Kaiser's political-influence helped create enemies within the military's hierarchy as the Navy preferred escort carriers along the lines of the Sangamon and Commencement Bay classes. Both classes were constructed on tanker hulls which afforded greater aircraft carrying capability and high performance than the merchant hulled Casablanca class. After FDRs death, any future development that bore the Kaiser name would also have to overcome the resistance created by that former "political influence".

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Naval Fighters Number Forty--Eight : Kaiser Fleetwings XBTK--1

At upper left, the Kaiser-built Casablanca class carrier, the USS Makin Island (CVE-93) in November 1945. At left, a Fleetwings stainless steel Seabird. (via Fred Freeman)

KAISER FLEETWINGS XBTK-1 BY BOB KOWALSKI

BACKGROUND

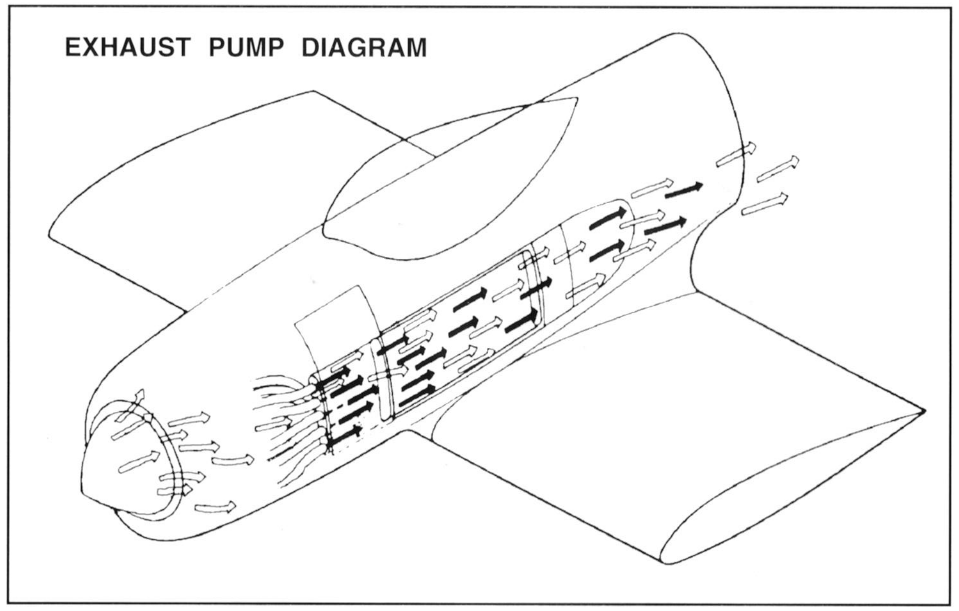
The Kaiser Fleetwings XBTK-1 was initially designed to meet a 1943 Navy requirement for a "single-seat carrier based high performance dive bomber". As was the normal war-time practice, design studies were requested from companies without a major production model and, with the Navy's acceptance of the proposal from the Fleetwings company, the design was designated XBK-1. A change in requirements to include the torpedo bomber mission occurred sometime between 29 September 1944 and April 1945 and resulted in the consequential change in aircraft designation to XBTK-1. That change also caused the re-titling of all the pertinent documents so that the first document, entitled NAVAER SD-367, was changed from XBK-1 to XTBK-1. The design specification, dated 10 January 1944, was concerned with the two XBK-1 prototypes (BuNos 44313 and 44314, Lot 1). The 29 September 1944 addendum included changes recommended by the mock-up board and was for 20 airplanes (BuNos 90484-90503). The size of this order is an example of the Navy's policy of producing a squadron-size complement of airplanes for the purpose of expediting the testing process, rather than being indicative of its acceptance of the design.

Above, artist's rendition of the XBTK-1 attacking a Japanese carrier. (National Archives)

Fleetwings Inc. of Bristol, PA, was founded in 1929 and had built several designs, including the Army Air Corps BT-12 trainer, that utilized stainless steel. Since a design feature of the XBTK-1 involved the use of stainless steel, Fleetwings' proven ability to work with that material may have been a factor in their selection. Coincidentally, their location in the Delaware Valley was near Philadelphia where the Budd company manufactured a stainless steel transport airplane, the RB-1 Conestoga for the Navy. In 1943, Fleetwings was engaged in the production of components for several combat aircraft when they were acquired by Henry J. Kaiser. As a result, Fleetwings would become the Fleetwings Division of Kaiser Cargo Inc. Kaiser Cargo, a subsidiary of the shipbuilding organization, would be responsible for managing the production of the XBTK-1.

Aviation history has generally remembered the Kaiser Fleetwings XBTK-1 as having been a lightweight competitor of the Martin XBTM-1 Mauler and the Douglas XBT2D-1 Skyraider designs. Being developed in the same time-frame as those airplanes seems to have been the common-thread that has linked the XBTK-1 to them. But the XBTK-1's significantly more limited armament and range capability suggests that it was designed to meet a different requirement than the others. If the XBTK-1 wasn't designed to meet that same requirement the question obviously arises, what was it designed for? This study offers that the XBTK-1 was designed to be operated from escort carriers as a single-place dive bomber/scout airplane whose potential then allowed it to include the torpedo bomber mission.

The extent of the US Navy's use of escort carriers is perhaps best appreciated by recalling the 1944 amphibious landings on Leyte that initiated our recapture of the Philippines. Escort Carrier Task Group 77.4, with sixteen CVEs equipped with General Motors TBMs, was responsible for providing direct air support of those landings. The fact that the close air support mission was being performed by the TBF-1/TBM-1 is more a credit to that airplane's versatility and good flying characteristics then to its being the right-airplane for that use. The need for a more advanced specialized close support aircraft would be increased by the late-war addition of the nineteen ship Commencement Bay class of escort carriers.

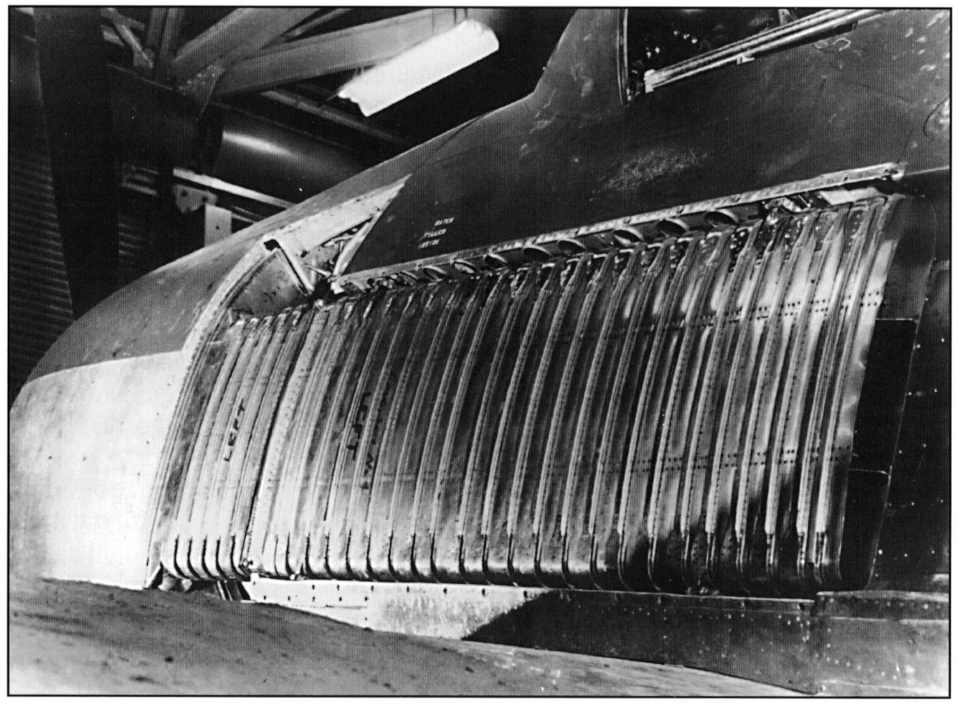


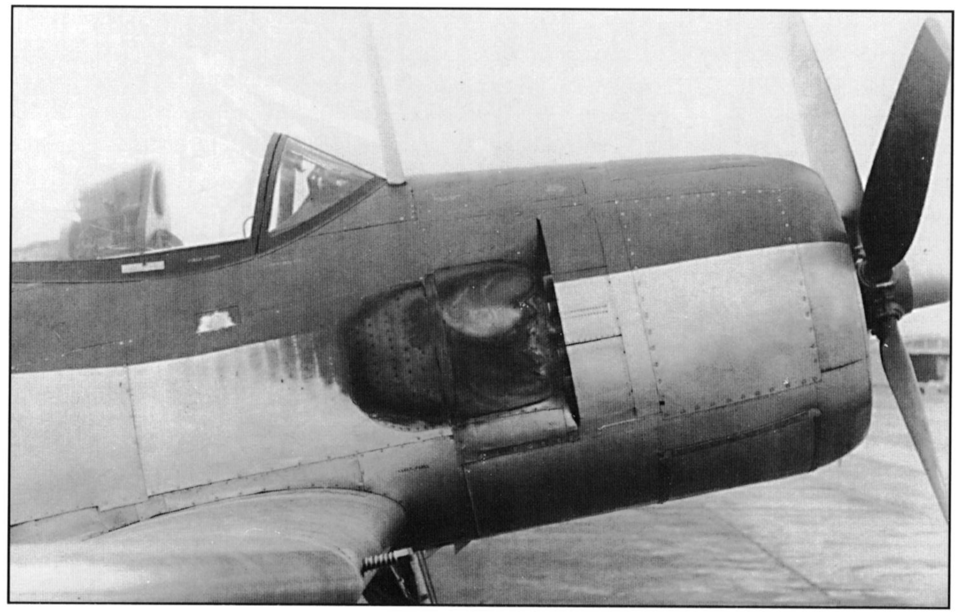
Above, exhaust pump diagram. Black arrows represent hot engine exhaust and the white arrows represent cool air flow. (National Archives)

When first flown in April 1945, the airplane was equipped with the engine cooling system that has endured as its best-remembered design feature. This system was the result of BuAer-sponsored industry-wide studies which had shown potential for reducing the drag caused by the engine's cooling air as it exited into the airstream at high airspeeds. In theory that combination of cooling air and exhaust gases would, because of their direction and velocity, convert what had been drag into net thrust. As designed, this "exhaust pump" used the engine cooling air which, after having its velocity increased by the spinner and propeller cuffs, would continue around the engine and through the firewall in two exhaust ducts located on each side of the fuselage. Within these ducts, the cooling air would mix with the exhaust gases and the combined mixture would pass through pilot-controlled duct flaps before exiting overboard aft of the cockpit. The exhaust ducts, their cooling flaps and the adjacent section of the fuselage were constructed of stainless steel to minimize the corrosive effects of the exhaust gasses. Similarly, the fuselage skin of the exhaust-area was protected by being painted black. The first flights at Fleetwings had revealed engine cooling problems and a fuselage vibration that was amplified by the exhaust ducts. As a consequence, provisions for a conventional exhaust system were begun.

During May, while BuNo 44313 was back in the shop to incorporate various required items and correct structural deficiencies, the originally specified Pratt & Whitney R-2800-22W engine was replaced by a R-2800-34W. This change in the production standard took advantage of the -34's higher horsepower ratings in high blower operations. By July, the cockpit was provided with controls for both the mechanically operated duct flaps and the electrically operated conventional cowl flaps. Flight testing resumed in preparation for the Preliminary Evaluation at the Naval Air Test Center (NATC).

Below, exhaust pump system ducting as seen when the outer fuselage skin was removed. (USN)





Above, BuNo 44313 with conventional exhaust with cowl flaps closed on 26 September 1945. (USN) Below, 44313 with cowl flaps open. (USN)

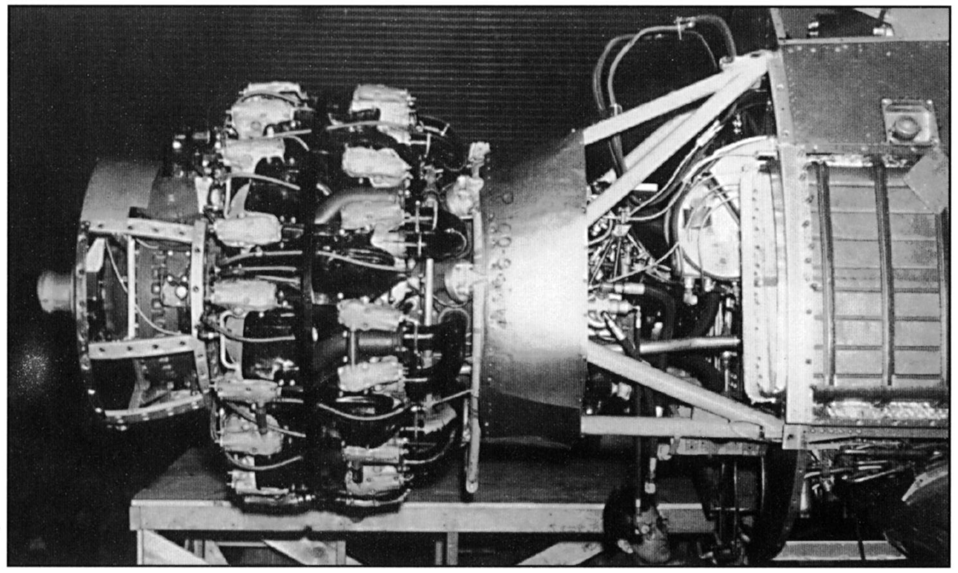
BuNo 44313 was received by Flight Test Division at the NATC, Patuxent River, MD, on 9 August 1945. The trials ended on 8 October 1945 with an accumulation of 86.0 hours of flight testing. For the trials, the airplane was not accepted by the Flight Test Division but remained the property of the contractor. This would explain why the airplane was neither painted or marked in accordance to Navy specifications. The Final Report of the Preliminary Evaluation, NATC Report Serial No: FT-C-430, stated the following purposes for the trials:

1.) To determine, in a limited degree, the performance of the airplane.
2.) To evaluate the stability and control of the airplane.
3.) To evaluate the general handling characteristics of the airplane.
4.) To evaluate the results of such additional inspections and tests as were considered to be necessary, including a comparison of exhaust pump installation with the conventional cowl flaps installed.

It was concluded from the tests that there was no performance advantage to the exhaust pump installation. "Performance of the airplane was substantially the same with either the exhaust pump or the conventional cowl flap installation". Addressing the cooling problems, the report concluded: "power plant cooling with the conventional cowl flap installation, though unsatisfactory, was superior to the exhaust pump installation". Furthermore: "No ground runs were made with the exhaust pump installation, but cylinder head temperature went to 230°C during taxiing". The significance of that is best appreciated when one recalls that 232°C was the cylinder head temperature (CHT) limit for continuous operation of these late-models of the R-2800 engine. Therefore, it's apparent that if the engine temperature is at 230°C before takeoff, the potential for operation above the take-off power maximum temperature limit of 260°C does readily exist.

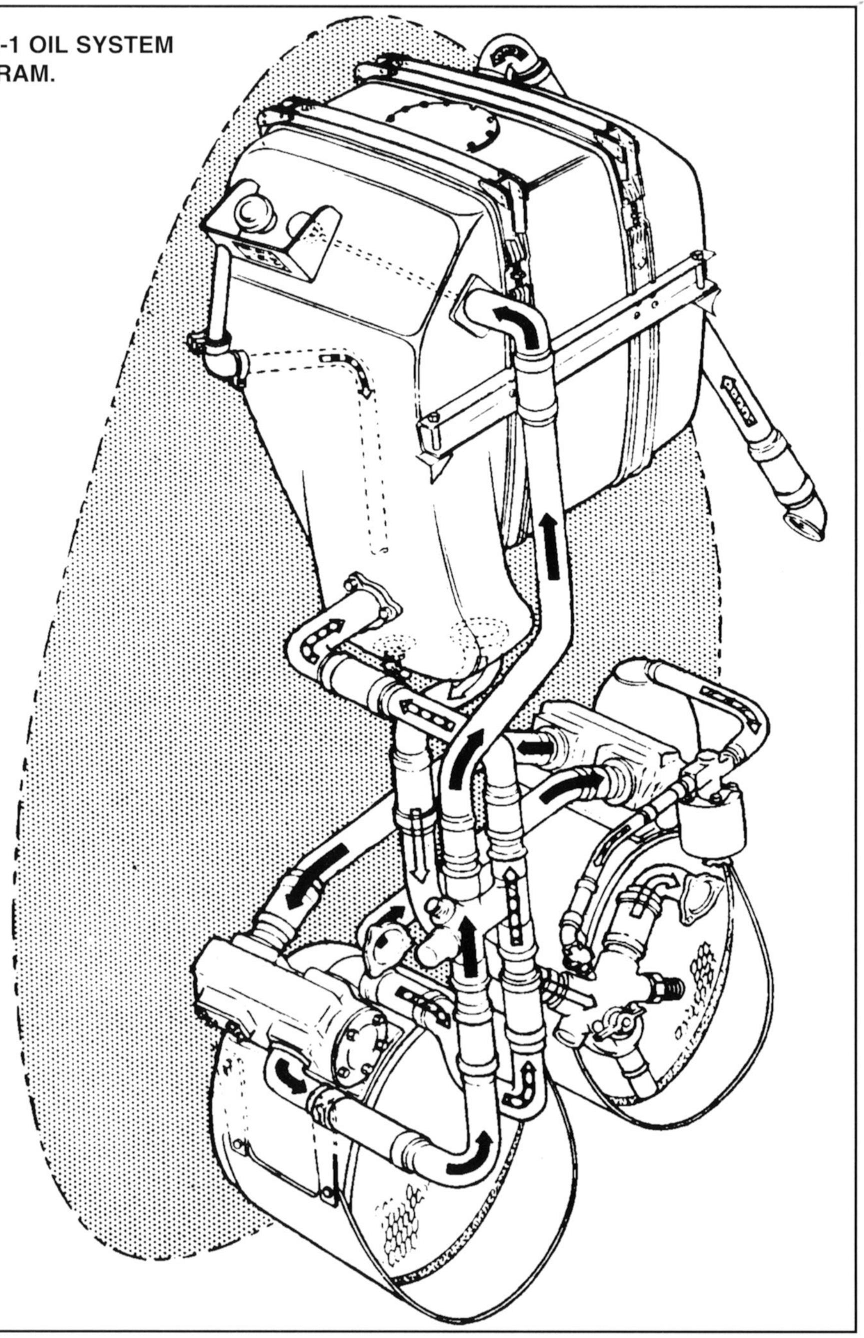
The following detrimental conclusions concerning pilot comfort are noteworthy: "The cockpit was much cooler with the cowl flap installation'. and "With the exhaust pump installation, the fuselage skin temperature after engine shutdown made cockpit entrance or egress difficult". Either of which would have brought discomfort to the pilot and put an added meaning to the term "hot-seating" as used during CarQuals.

Among the advanced features utilized to both improve the engine's performance and simplify its operation, the Pratt & Whitney R-2800-34W engine incorporated a single-stage two-speed supercharger, an automatic manifold pressure regulator and a water injection system. The single-stage, two-speed supercharger had, after much war time effort directed towards improving its operating efficiencies, developed into the Navy's supercharger of choice. Relative to a two-stage unit, these efficiencies included the use of less mechanical energy to operate (leaving more horsepower to drive the airplane's



At left, XTBK-1 powerplant with cowlings removed on 10 February 1945. (National Archives)

XTBK-1 OIL SYSTEM DIAGRAM.



propeller) and an improved thermodynamic efficiency which created a cooler air charge for the carburetor's use. With the elimination of the second stage (aka. aux stage) and its associated intercooler, the powerplant would be lighter, thereby maximizing the airplane's performance. From the pilot's standpoint, the single-stage, two-speed supercharger meant just one blower shift during his climb to altitude. Although the blower shifts could be made at any RPM, they were made after reducing MAP (the engine's manifold absolute pressure) and RPM because "loads imposed on the blower drive mechanism during shifts fall off quite rapidly with reduction of engine speeds".

The MAP regulator was a bellows-type arrangement, installed between the cockpit throttle and the carburetor throttle, and was incorporated to assist the pilot with:

1.) Maintaining selected manifold pressure regardless of variation of RPM and/or altitude, within the capacity of the supercharger to produce the manifold pressure selected.
2.) Resetting manifold pressure when shifting from low to high, or, high to low blower.
3.) Obtaining Combat Power manifold pressure when using water injection.

Although the MAP regulator became the standard for high performance reciprocating-engined airplanes because it simplified their operation, its use required pilot awareness of its possible component-related failures (either its oil system or bellows) and required changes in his power-management techniques.

The water injection process was incorporated to produce the highest power, within reasonable safety limits, that the structural limitations of the engine would permit. Simplistically, this was accomplished at the carburetor by lowering the amount of fuel in the fuel / air ratio (de-richening) and then downstream of the carburetor, replacing that with a water mixture injected into the impeller. Since the water was used to suppress detonation, that purpose creates the system's other name, Anti Detonation Injection (ADI). For its reciprocating engine anti-detonate (ADI) fluid, the Navy used a 50/50 mixture of water and alcohol with the alcohol being included to prevent fouling of the system's plumbing from any residual fluid. The power attained was known as either Combat Power or War Emergency Power and offered an increase in MAP without any cylinder-head temperature (CHT) or time limit. To obtain combat power, the XTBK-1 pilot would merely push the throttle past their take-off stop, turning the water injection pump ON and de-richening the fuel air mixture, to a second stop (the firewall stop) to obtain Combat Power. The specified 10 minute supply of ADI fluid served as the controlling time-factor for the system's use. The prototypes were provided with an ADI quantity gauge, but the production models had an ADI pressure gauge located beneath the armament panel on the production models. A Power Water Injection Pump circuit breaker was located on the circuit breaker panel and served to de-activate the water injection pump if the throttle switch failed to turn it off after its use.

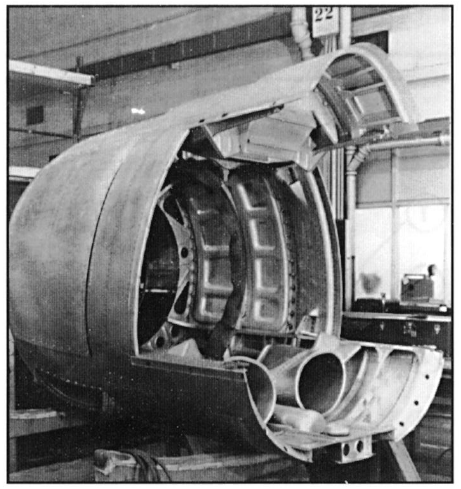
That discussion of this trend towards simplification of the operations of these piston powered, radial engines was offered to show that the need-to-simplify was recognized. The coming use of jet engines, made to exploit their greater power potential, brought that simplification along as a consequential benefit.

Although the Hamilton Standard Hydromatic propeller was arguably the finest ever, its one weakness was that a loss of its oil pressure would cause a loss of its governing ability. If that loss occurred during high-speed, high-power operations such as during combat, centrifugal forces would twist the blades into a flat-pitch resulting in an overspeed condition (R-2800-34W limit, 3,250 RPM for 30 seconds) and subsequent destruction of the engine. To give the pilot an opportunity to retain some control in that situation, a pitch lock system was part of the Super-Hydromatic propeller.

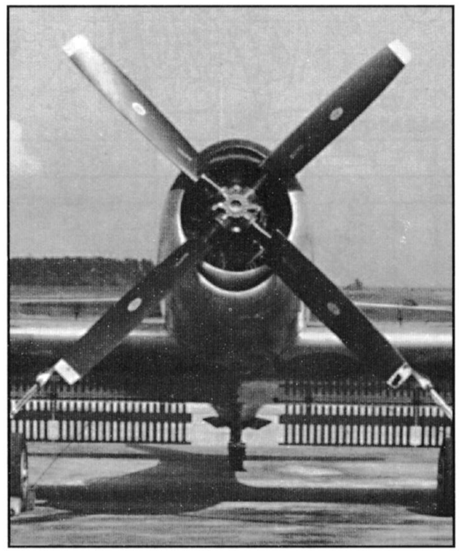
On the XBTK-1, the Super-Hydromatic propeller was used in conjunction with the exhaust pump system and can be readily identified by its lack of the distinctive Hamilton Standard governing dome. The dome-less Super-Hydromatic propeller can be further distinguished from its contemporary Aeroproducts propeller (which equipped the AD and F8F) by the squared-off cuffs at each blade's hub end.

The results of the Super-Hydromatic propeller's evaluation included the following unsatisfactory conditions ".....the propeller governing was inadequate. RPM surges of 30 to 200 RPM were encountered" and "The propeller pitch lock was unsatisfactory in that locking the pitch caused a decrease of as much as 150 RPM from the unlocked setting". Although the Super Hydromatic didn't gain acceptance, a pitch locking device became a feature of the Hydromatic propeller associated with the turbo-compound models of the R-3350 engine.

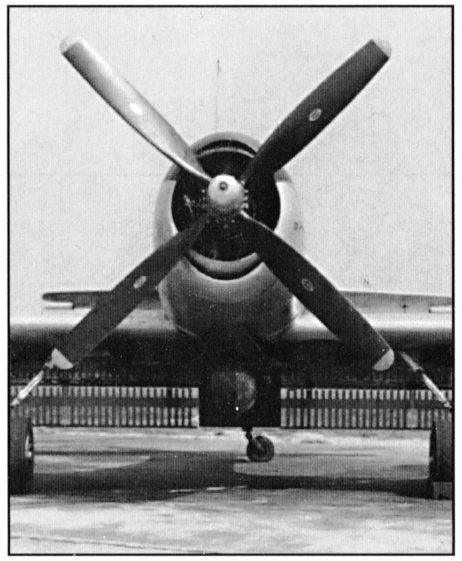
The maximum fuel quantity of the airplane was 375 gallons, which was provided by one hammock type self-sealing tank of 275 gallons capacity mounted aft of the pilot, and one-100 gallon tank carried on the left wing rack. Lot 2 airplanes were to be provided with a fuel transfer system to permit "topping off" the main tank from the droppable tank while in flight. All fuel lines were self-sealing except for the line that ran from the droppable tank disconnect in the wing to the fuel tank selector valve, which "may be non-sealing because fuel will not be retained in the line after the tank is dropped". The fuel flow was provided by the engine-driven pump and supplemented by an electric auxiliary pump. The AUX pump switch was located next to the fuel tank selector control and normally used for: engine start, take off, shifting fuel feed from one tank to the other, fuel



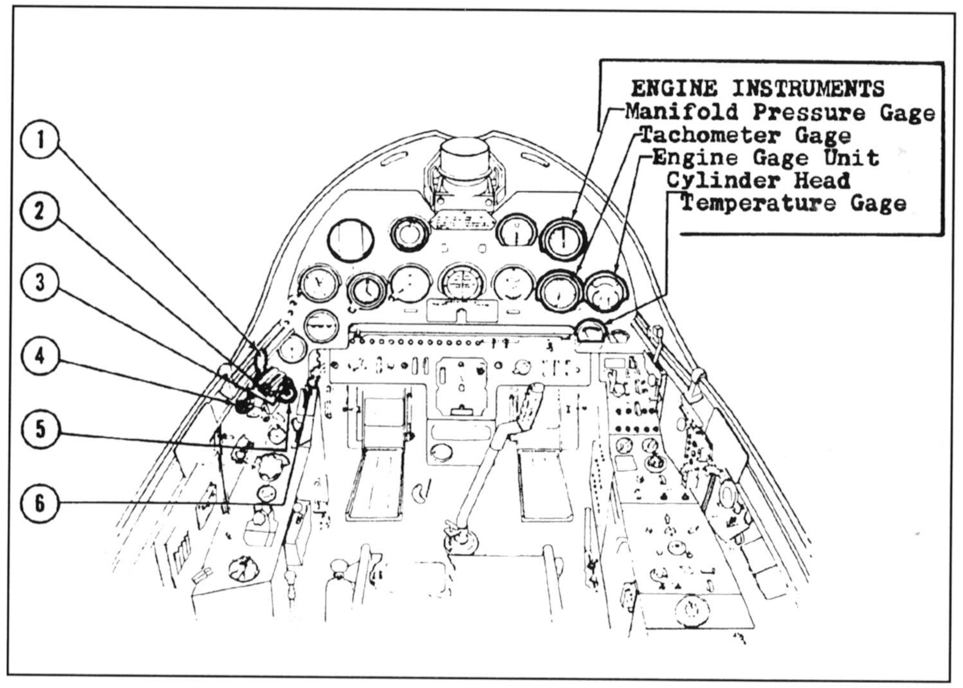
Above, power plant cowl assembly.

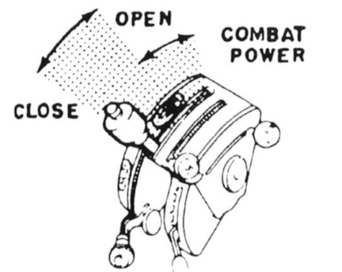


Above, the domeless Super-Hydromatic propeller was the intended XTBK-1 propeller. Below, when the exhaust pump system proved ineffective, a Standard Hydromatic propeller was tested. (USN)

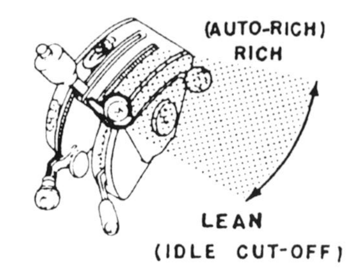


POWER PLANT CONTROLS

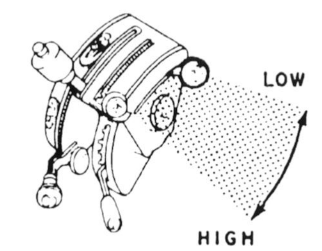




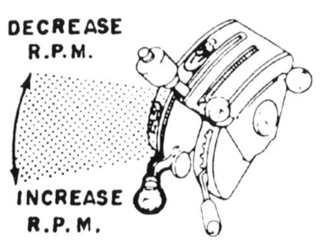
① **Throttle Control**



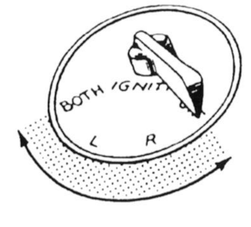
② **Mixture Control**



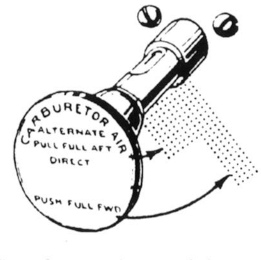
③ **Supercharger Control**



④ **Propeller Control**



⑤ **Ignition Switch**



⑥ **Carburetor Air Control**

transfer and landing. Its emergency function was to back up the engine driven pump in case of its failure. The fuel pressure (21-23 pounds) was picked up downstream of the carburetor and displayed on its gauge located below the engine gauge. For protection, an armored bulkhead was installed between the fuel tank and the pilot.

The BIS trials revealed that the "Fuel quantity gauge was poorly located in that it was not visible to the pilot in flight". It was located in the lower left-hand corner of the main instrument panel where the cockpit-sill blocked the pilot's view. Furthermore, the "prototype's fuel tank installation required movement of the canopy partially forward to allow access to the filler neck".

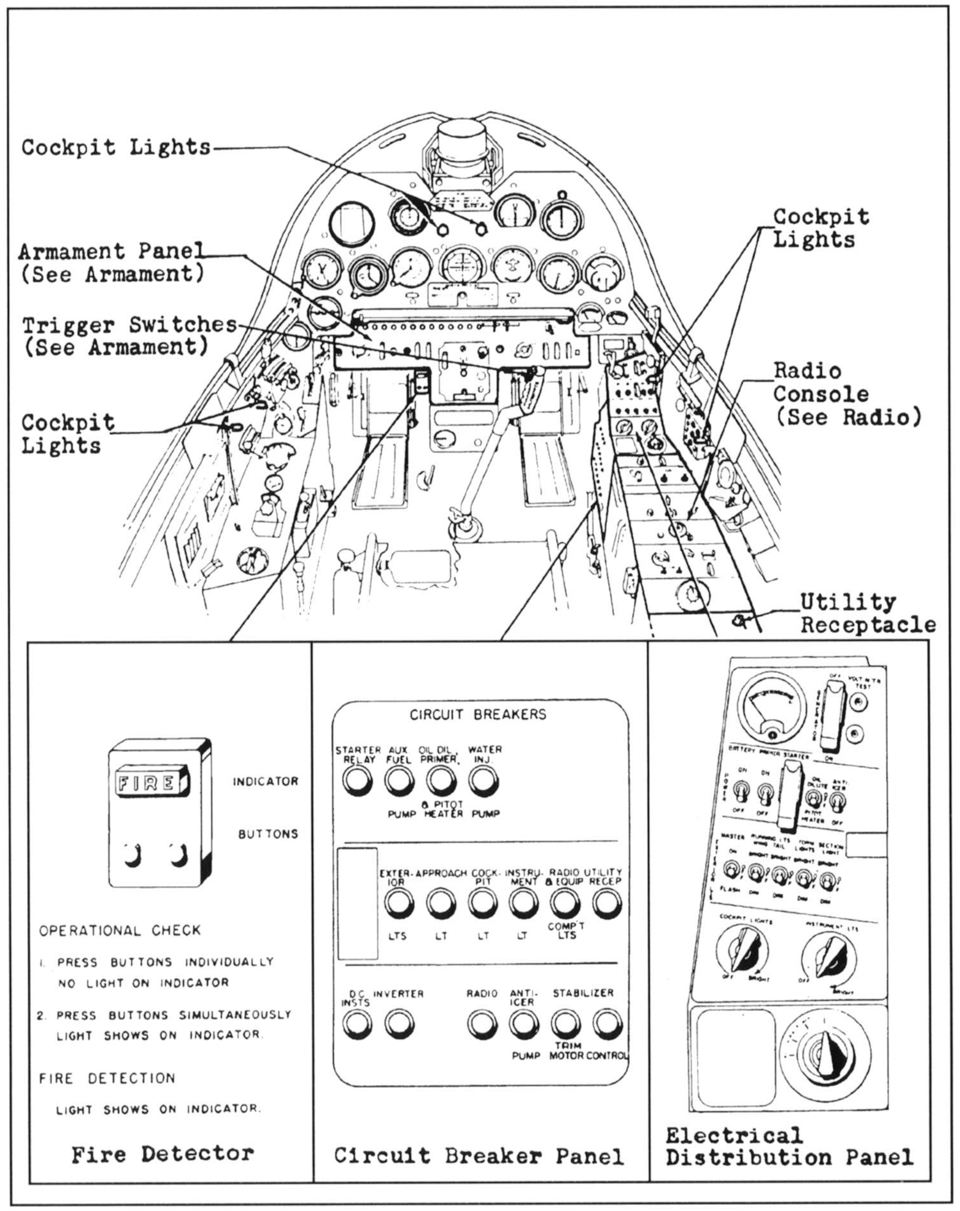
To assure an adequate supply of oil for lubrication of their reciprocating aircraft engines, the Navy required that its airplanes' oil quantity be 1/18 of the maximum fuel quantity. As a consequence, the XBTK-1 was provided with an oil tank that included the required capacity of 21 gallons plus space (about equal to 5 gallons) to allow "foaming" of the oil. The tank was located forward of the firewall (see page 4) with its filler neck on the right. Additionally, the oil that was contained in the lines that ran from the tank to the engine, and from the engine through the oil coolers to the tank (totalling about 6 gallons), would be labeled "residual oil" for weight and balance computations. The oil coolers contained integral automatic temperature control valves and were, in addition to the pilot's armored-bulkhead, the only other area protected by armor plate. Finally, the lubrication system included an oil dilution system for use when ambient temperature for engine start was, or forecast to be, below 35° F.

The electrical power supply consisted of a 28 volt direct current system and a 115 volt 880/1600 cycle alternating current system, both powered by the engine-driven generator (NEA-5). The only other source of power was a 24 volt, 34 amp. hr. battery. The 115 volt AC system was used to feed the radios, IFF and radar while an DC to AC inverter, powered from the DC system, also provided reduced voltage AC to the remote compass and some flight instruments. All circuits, except for the IFF detonator circuit, were protected by circuit breakers located on the vertical panel adjacent to the distribution panel side of the right console. The pilot was provided with a battery switch and a guarded-generator field switch grouped together on the right console. In normal operations the battery and generator switches would be ON except for emergency operation or when testing the generator's "no-load" voltage. The electrical system's only gauge normally read amperage, but by depressing the VOLT METER TEST button (located to the right of the generator switch), the pilot could read its DC voltage. A warning light (also located alongside the generator switch) would illuminate when the generator's output was below 26.5 volts. This would occur when the engine RPM was below its generator's "cut-in" speed of 1,025 to 1,050 RPM. The system was supported by a dual source (AC or DC) external power receptacle located in the starboard wheel well.

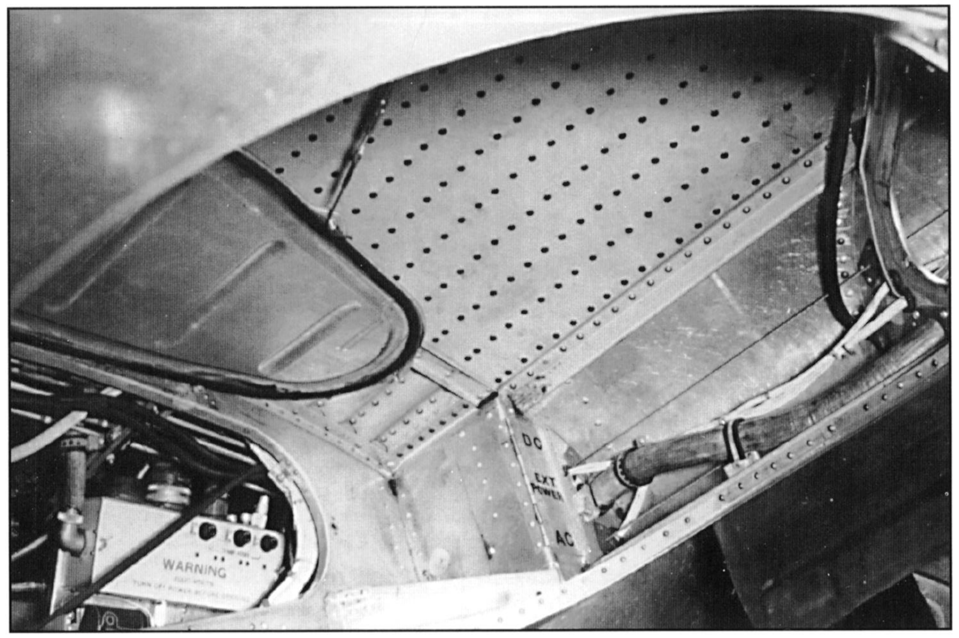
The hydraulic system consisted of a main pressure system, an emergency pressure system and five sub-systems. Either pressure system could power the sub-systems which consisted of: landing gear extension and retraction, wing folding and spreading, canopy movement, landing flap and dive brake operations and gun charging. The hydraulic reservoir held 4.2 gallons of hydraulic fluid and was located aft of the firewall with its filler neck located on the left side.

For normal operations, the pilot was provided the standard sub-system controls, a hydraulic pressure gauge (located forward on the left

ELECTRICAL SYSTEM CONTROLS

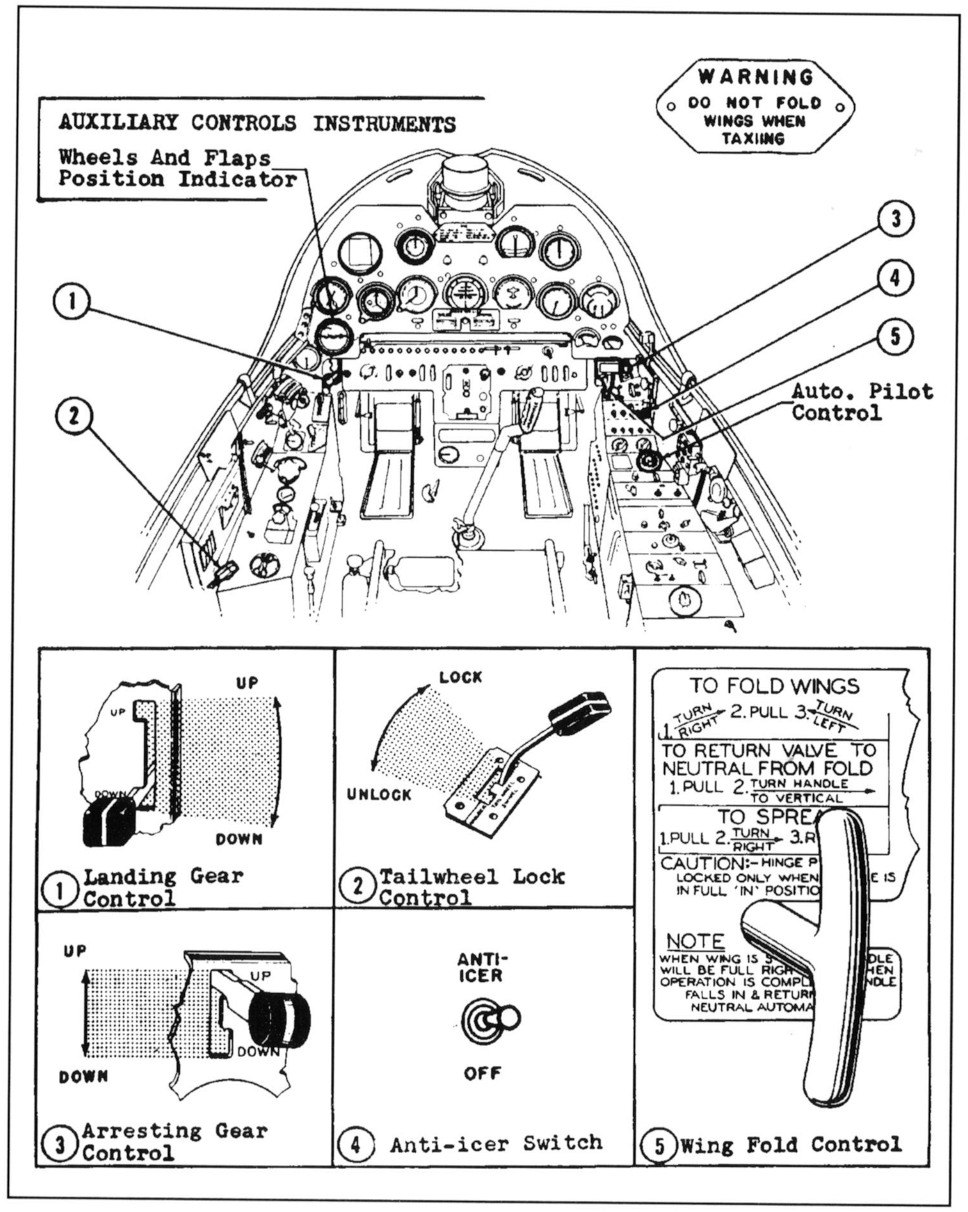


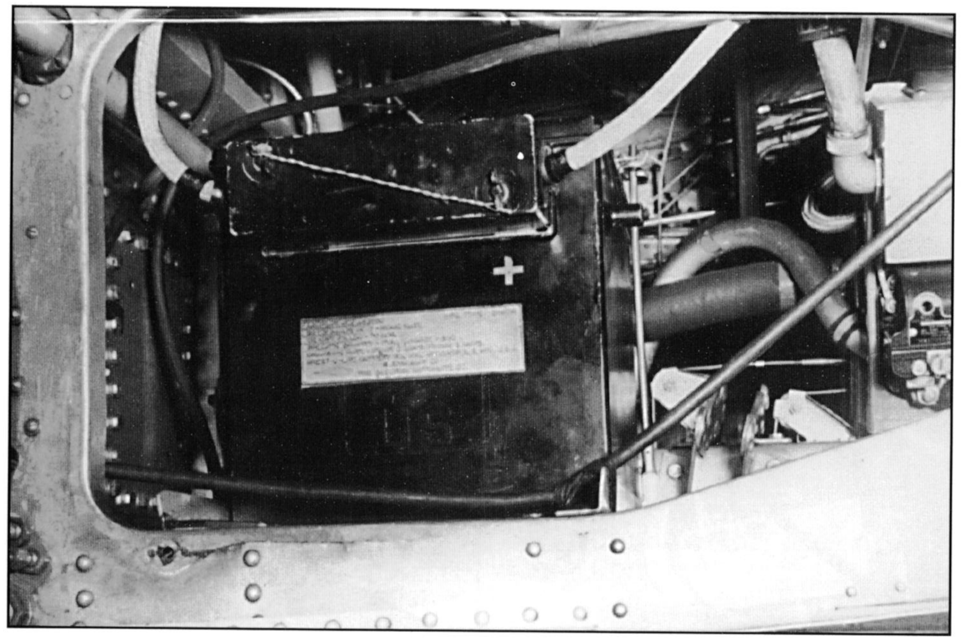
Fire Detector **Circuit Breaker Panel** **Electrical Distribution Panel**



At right, wheel well mounted AC/DC external power receptacle. Accessory compartment door is in the open position for access to the electrical equipment including the battery. (USN)

AUXILIARY CONTROLS





At left, battery installation inside the aft end of the accessory compartment, which is accessed through a door in the wheel well (see page 7). (USN)

console) and a cockpit sight gauge to monitor the reservoir's fluid level. The hydraulic fluid entered the system through a stand-pipe in the reservoir and was pressurized by an engine driven pump to 1,500 psi. When the engine driven pump was unable to provide sufficient pressure, the pilot was provided with a hand pump (located on the cockpit floor to the pilot's right). That arrangement of separate supply sources for the two hydraulic pumps also allowed an emergency supply of fluid to be available to the hand pump in case of a line failure in any sub-system.

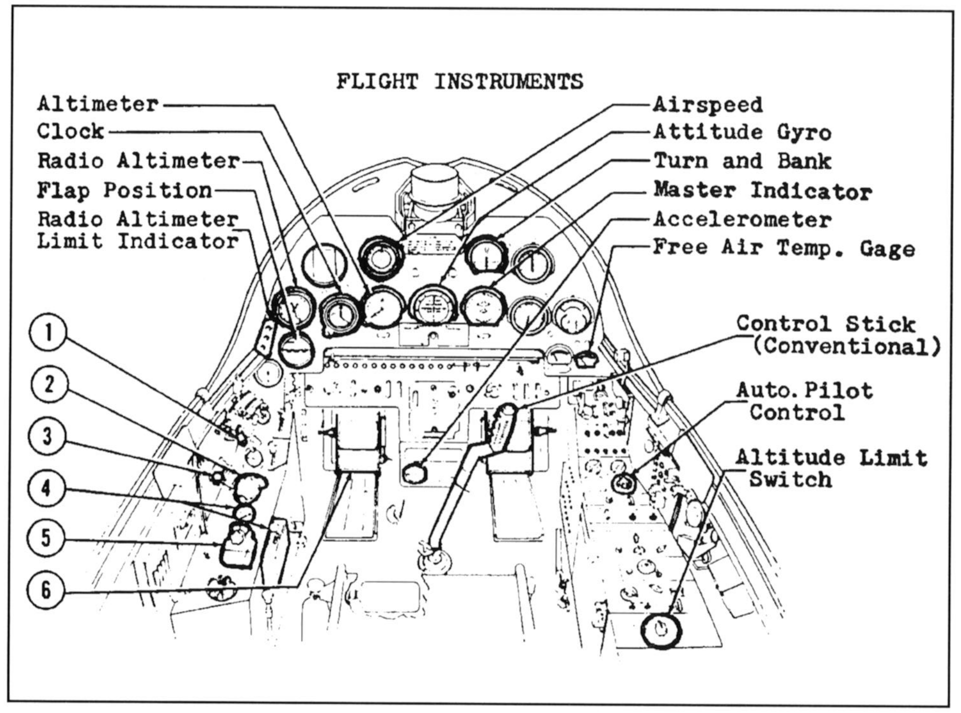
When sufficient hydraulic fluid was not available for normal or emergency use, two by-pass valves (the canopy cycle by-pass valve and the landing gear cycle dump valve) were provided in their respective sub-systems. The canopy valve was controlled through its Emergency Control Knob and could be operated from either within or outside the cockpit to allow manual operation of the canopy. The landing gear could be extended by the use of the Hydraulic Dump Valve (located on the side of the left console) to unpressurize the landing gear hydraulic lines. In flight, the pilot could then put the landing gear lever DOWN and dive to use the increased g forces encountered during the pull out to help extend the gear. If that failed to lock the gear into their DOWN position as displayed on the combination wheel and flap indicator, he could "yaw" the airplane to utilize the airstream to force a wheel into its locked position.

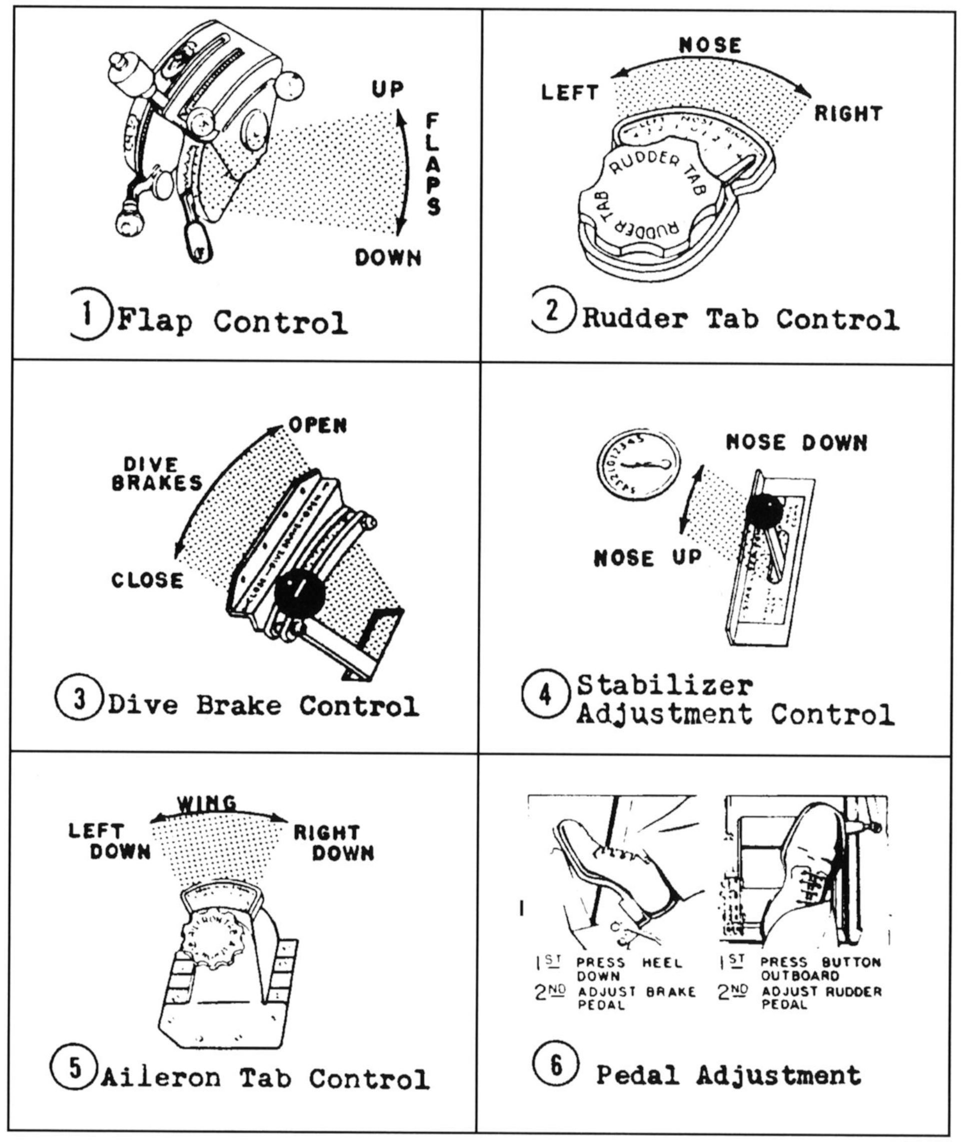
Since the omission of a dedicated emergency extension system saved weight, perhaps it and other weight-saving measures (as, no provision for emergency lowering of the flaps) were implemented to help keep the XBTK as lightweight as possible for its planned use aboard CVEs. Perhaps for the same reason, the Navy's standard requirement for a "howler" (warning horn to indicate that the landing gear wasn't down when the throttle was closed) was deleted.

Other than the dive brakes and landing flaps, the hydraulic system was not used to power any flight controls. All other controls were controlled from the pilot's control stick and rudder pedals through cables to balance tabs located on the right aileron, the rudder and both elevators. The use of a dual installation for the elevators was "to avoid failure of both sets of controls in combat". These balance tabs were aerodynamically balanced (by amount of overhang of their leading edges) and their deflection would cause their flight control surface to displace itself into the airstream. On the elevators and ailerons, the tabs also utilized springs (making them "spring balance tabs") which, by providing a given portion of the required control force, served as "boosts", avoiding any need for hydraulic-boosting. Similarly, the balance tab on the rudder provided incremental force but also functioned as the trim tab, thus becoming a "trim balance tab". A suitable "parking harness" was provided to permit locking the surface controls in their neutral position when the airplane was parked.

The trim system consisted of the rudder's trim balance tab, a conventional trim tab installed on the left aileron and in lieu of elevator trim tabs for longitudinal trim, and an electrically-actuated adjustable horizontal stabilizer. This type of longitudinal trim system was in use by several fighter aircraft of the Axis-powers, with the Focke-Wulf 190 that entered service in 1941 perhaps being its first widespread application. During the war, BuAer sponsored several conferences with industry for the purpose of disseminating the intelligence gathered from inspections of enemy equipment. Therefore, credit for the use of this "flying-tail" installation, which also equipped the Douglas XBT2D-1 (AD), should be given to BuAer as well as to those aircraft designers who had the foresight to use it.

FLIGHT CONTROLS AND INSTRUMENTS





The horizontal stabilizer was controlled by the pilot through a switch lever located on the side of the left console (where the conventional elevator trim control would be), and provided with a gauge located next to the switch lever to show the stabilizer's angle of incidence. The final report's only criticism was that of the stabilizer's being ".... too sensitive, making it extremely difficult to trim for an exact speed". But for an indication of its broader application as an aerodynamic control, the report stated "The adjustable horizontal stabilizer was capable of reducing elevator control forces to zero over the entire speed range from V_{SL} to V_{MAX}". The high-speed limit (V_{MAX}) of this "entire speed range" can better be shown by the Bell X-1 when it became the first airplane to fly faster than the speed of sound on 14 October 1947. That aircraft was designed with an adjustable horizontal stabilizer referred to as "a flying tail". The need for which its pilot Chuck Yeager stated ".... in order to control the airplane through Mach One, we had to have a flying tail on it", and "That really was the answer to flying at supersonic speed".

Stability and control characteristics of the XBTK-1 were evaluated with the airplane in two configurations; "Design configuration" (dive bomber with 1,000 pound bomb, radar pod and drop tank) and "minimum drag configuration" (scout with no external stores and 50% internal fuel). The final report states: "Stability and control of the airplane were substantially the same with either the exhaust pump, or the conventional cowl flap installation".

The rudder's control power (a measure of the control surface's effectiveness) ranged from "adequate for the high speed range" through "marginal in the region of the stall" to "inadequate to maintain a straight course when full power was applied suddenly and the tail raised sharply to minimum drag position" (minimum run take-off).

For its assessment of the rudder's control forces (the amount of effort the pilot has to exert on that control surface to achieve his desired response), the final report included: "The wave-off characteristics were slightly impaired by the excessive rudder forces at low speeds" and "Rudder control forces were high in all configurations of flight". The "Changes in directional trim with changes in speed or power were excessive. The rudder tab necessary for trim moved from 7° nose right in configuration PA at 105 mph to 8° nose left in configuration P at 240 mph". Compare that to a jet-powered airplane's 0° rudder trim throughout its range of airspeeds in normal operations. The report's recommendations were to "Reduce directional control forces to specification values" and "Provide satisfactory directional control for carrier-type take-offs".

The elevator control had a low-speed/high-power combination deficiency: "was incapable of holding the tail down for carrier-type take-offs above 2,500 RPM and 35" of manifold pressure with the landing flaps full down". If uncorrected, this condition could have been compensated for by allowing the take-off roll to start with "brake release" at that power setting, much as used by the F4U. On the positive side however, "the max lift coefficient could be developed by the use of the elevator alone, even with full nose down trim". This high degree of elevator control power possibly contributed to its control forces being "excessively low" (3 lbs per g) for steady turns, and "light" for the landing where the power carried would be less than the 2,500 RPM and 35". However, it was during "quick pull-ups", a maneuver crucial to a dive bomber, that the elevator control forces were reported as being "1.5 lbs per g less than that for steady turns and is unsatisfactory". This condition if uncorrected could have allowed the pilot to exceed the airplane's g limits during "quick pull-ups" of his diving attack. The first place to correct some of these shortcomings would have been by changing the stiffness of the spring used in the elevator spring balance tab.

The ailerons were found in need of the following improvements: "provide satisfactory lateral stability in the landing condition" and "reduce high lateral control forces at high speed in clean condition".

The following observations of the airplane's stalling characteristics were valid with either the exhaust pump or the conventional cowl flaps:

(a) Except for configuration PA (carrier approach configuration) there was no definitive break in any of the stalls.

(b) Attempting to recover with minimum altitude loss resulted in a secondary stall (higher IAS than primary stall).

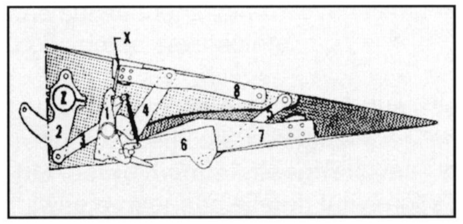
(c) All stalls were characterized by a "hanging on" of the stalled condition until a speed well above the stall was attained, or until application of power.

Stall recovery required 500 feet or less for all stalls except that most critical for the carrier pilot, the carrier approach configuration (PA), where "...the stall consisted of a sharp roll to the left and a sharp pitch. Recovery required 500-1,000 feet depending on technique used for stall recovery". Since our fleet pilots would have been no higher than 120 feet altitude through the last 90° of his approach, the report's conclusion that "Stalling characteristics are considered unacceptable" and recommendation to "Provide satisfactory stall characteristics" become readily apparent.

Up to now, the XBTK-1's wing had been provided with trailing edge flaps on the center section to lower the stall speed and utilized the aerodynamic technique of different angles of incidence "downwashing" for the wing sections. The angular difference, ranging from +2.0° at the root section to -0.2° at the construction wing tip, caused the stall to originate at the root section while the outer section, still above its stall speed, would continue to provide some lateral control.

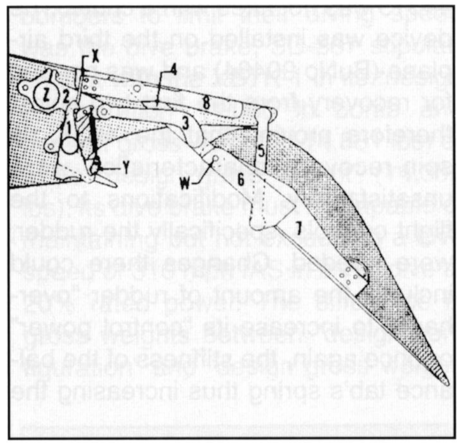
At right, lower finger-type dive brakes as seen from the front on 8 August 1945. (National Archives)

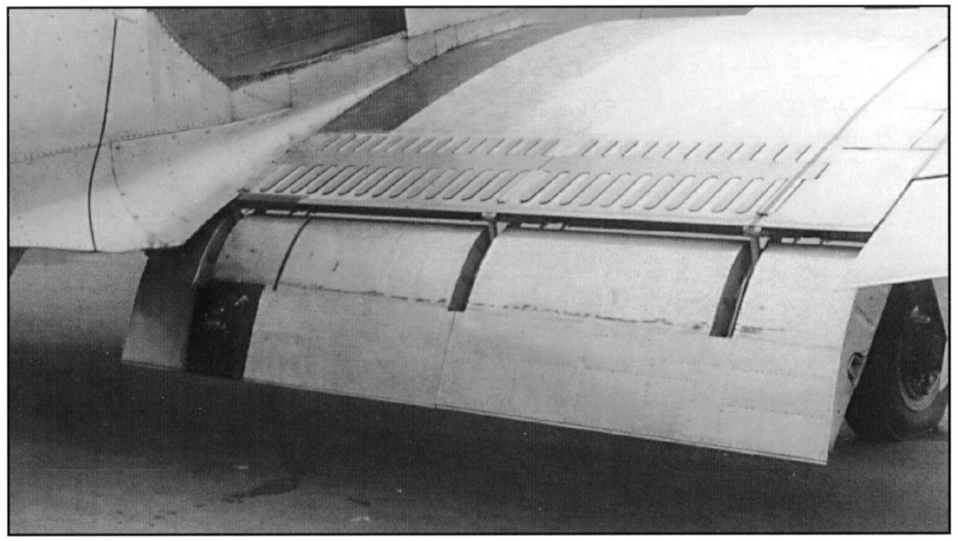
DIVE BRAKES AND LANDING FLAPS



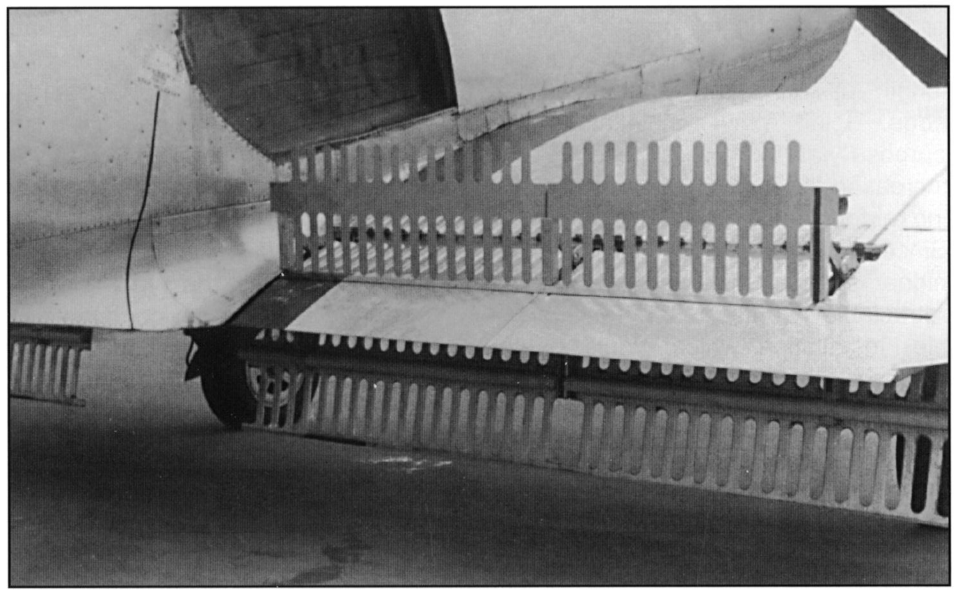
LANDING FLAP OPERATION

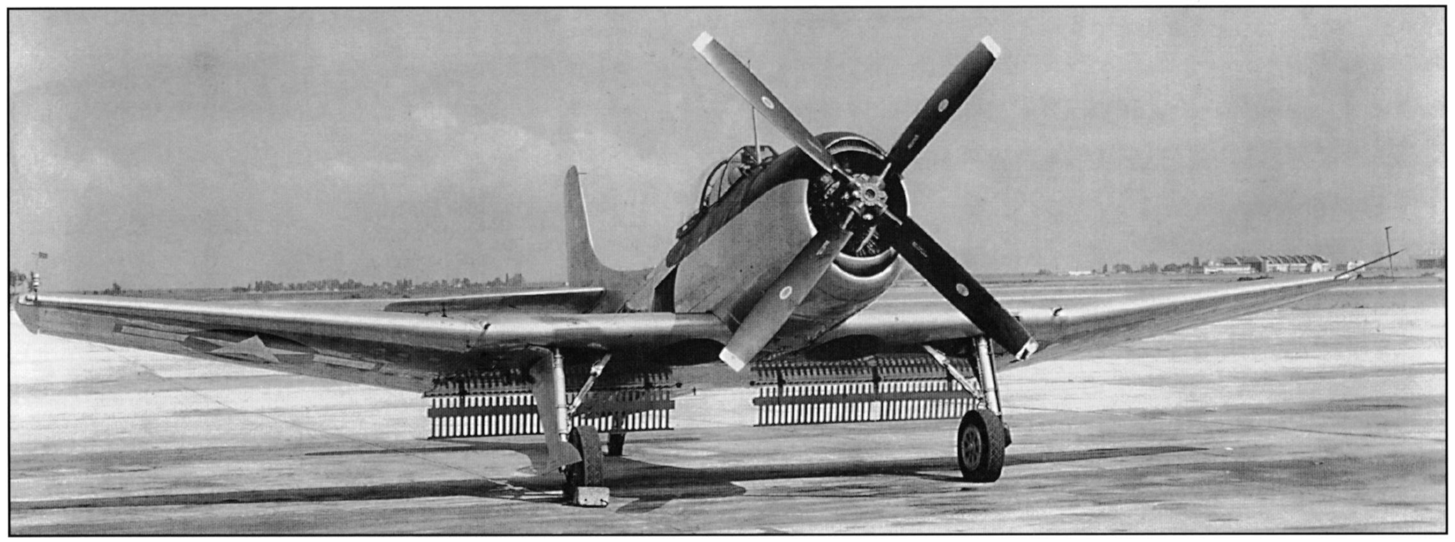
With the dive brakes locked in fully closed position by lock (1) holding lock plate (X), the action of torque tube (Z) is extended thru bell crank (2), link (3), link (4) to channel (6) which causes the flap to deflect by pivoting on links (4 & 5). Link (4) pivots on the upper dive brake hinge arm assembly (8), link (5) pivots on the wing trailing edge. When the flap is extended, latch (Y) engages the lip of lock (1) thereby preventing any movement of the lock until the latch is disengaged by lug (W) on interconnect when flap is returned to the fully closed position.

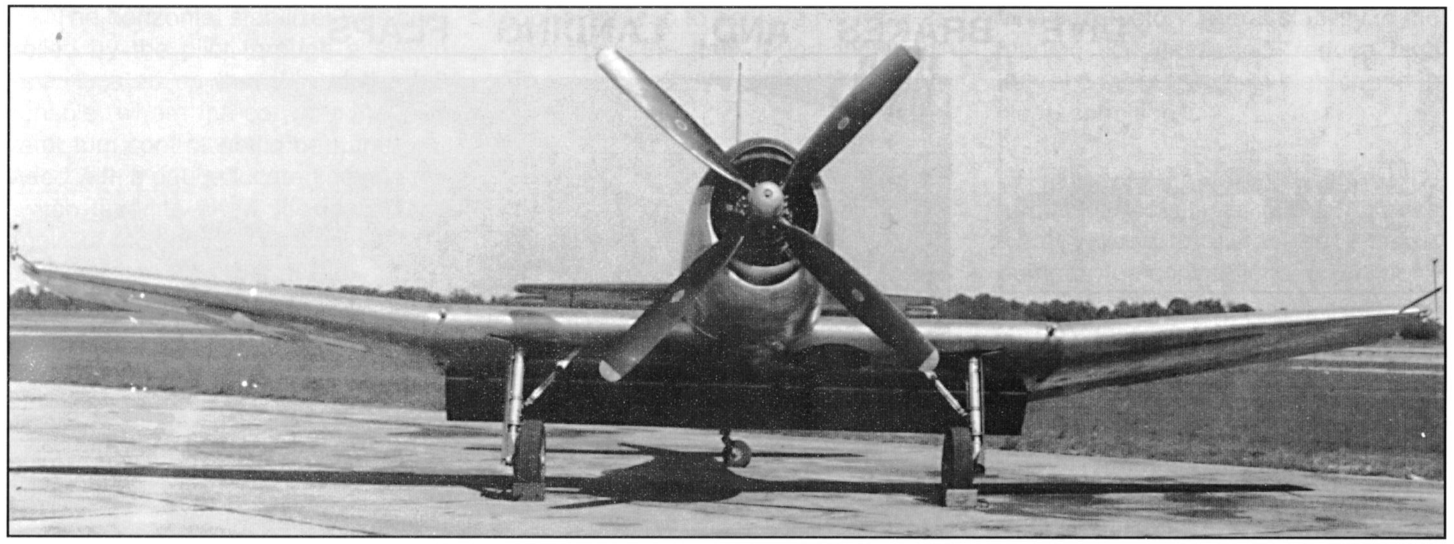




Above, landing flaps extended, Note how the upper wing finger-type dive brakes sit flat on the upper wings trailing edge when not deployed. Below, upper and lower finger-type dive brakes deployed. (National Archives)







Above, landing flaps extended, including center fuselage flap. (USN)

After completing the Preliminary Evaluation, BuNo 44313 returned to Fleetwings where, in response to that previous recommendation, its outer wings were fitted with fixed slats for testing purposes. Lacking any photos or documentation for proof, I'll offer that the slats extended along the full length of the outer wing's leading edge. Being a fixed-installation, its purpose was to help determine their increased lift coefficient on the existing airfoil in the low-speed regime. Since slats also create higher drag at higher speeds, their use requires a retractable (Curtiss SB2C for example) installation which would have entailed additional engineering and production delays for the XBTK program. A slot installation however, would also lower the XBTK-1's stall speed and be simpler to incorporate into the existing design. Additionally, slots offered several other advantages: no significant increase in drag at high speeds, being "fixed" they would not be subject to mechanical failure, their use was without the pitch changes caused during slat movement, and perhaps most importantly they would be lighter. After an outer wing modification that included the leading edge slots, the second prototype BuNo 44314, was completed in early 1946 and went on to demonstrate satisfactory stall characteristics which included a lowering of its stall speed so that, with "slightly over half flap" its stall speed was the same as the previous wing's full flap landing configuration.

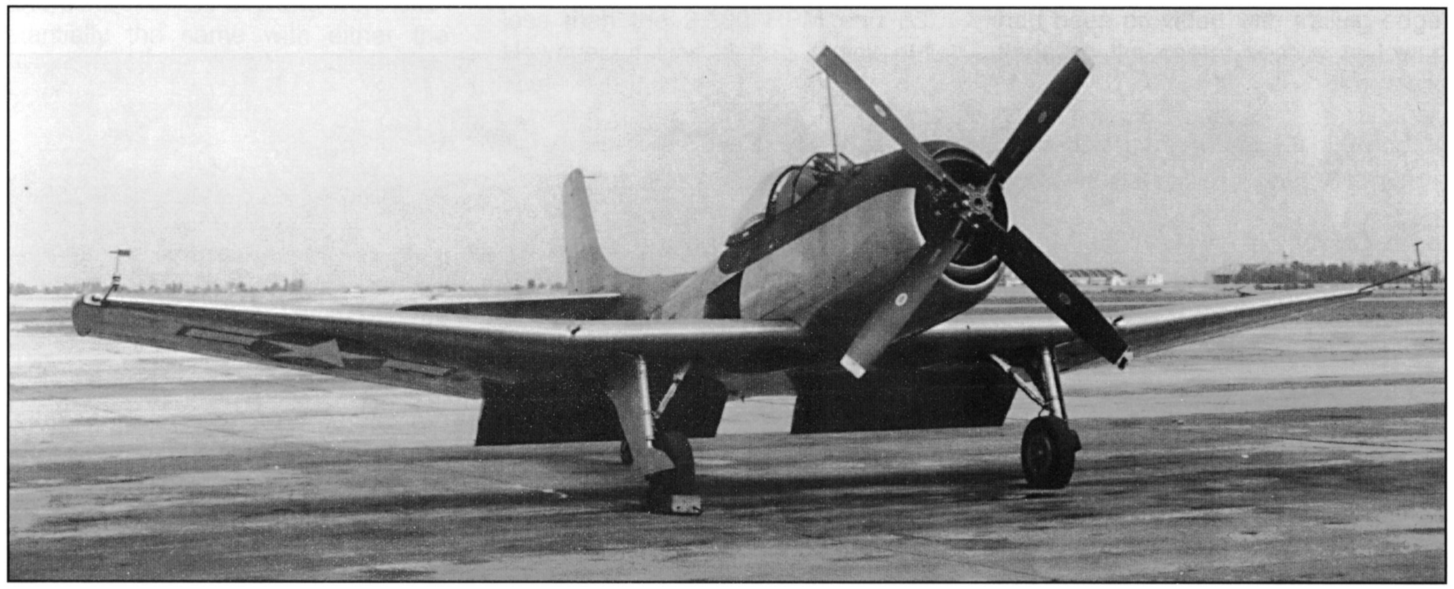
SD-367 specified that a suitable anti-spin chute be installed in the first experimental airplane. For whatever reason, spin tests were not part of the Preliminary Evaluation and BuNo 44313 was not fitted with a chute. The device was installed on the third airplane (BuNo 90484) and was needed for recovery from the first two spins, therefore proving that the XBTK-1's spin-recovery characteristics were unsatisfactory. Modifications to the flight controls, specifically the rudder, were needed. Changes there could include, the amount of rudder "overhang" to increase its "control power" or once again, the stiffness of the balance tab's spring thus increasing the rudder's "control force". Whatever modifications were made resulted in the subsequent spin-recoveries being considered satisfactory.

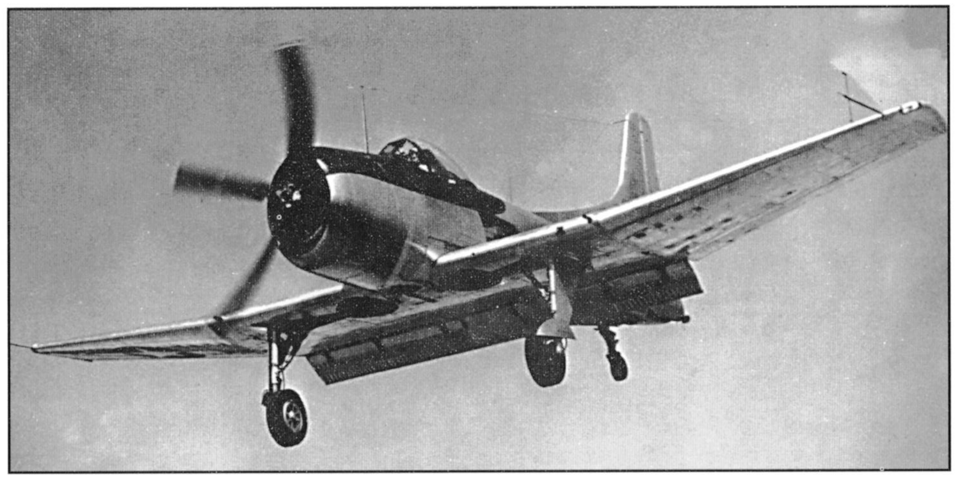
A recommended change, made more for the pilot's convenience than for aerodynamic reasons, was to "swap rudder and aileron trim knobs". This would place the aileron trim knob forward of the rudder's and be in agreement with what became the Navy's policy for their location.

The XBTK-1 carried its bomb load externally, the arrangement that had by 1943 gained favor with the Navy. Although the drag of the external bomb load during its approach to the target would penalize the airplane's range and speed, the benefits gained (simplified loading, a greater variety of loads that could be carried, fewer maintenance problems and once again, lighter weight) more than compensated for that.

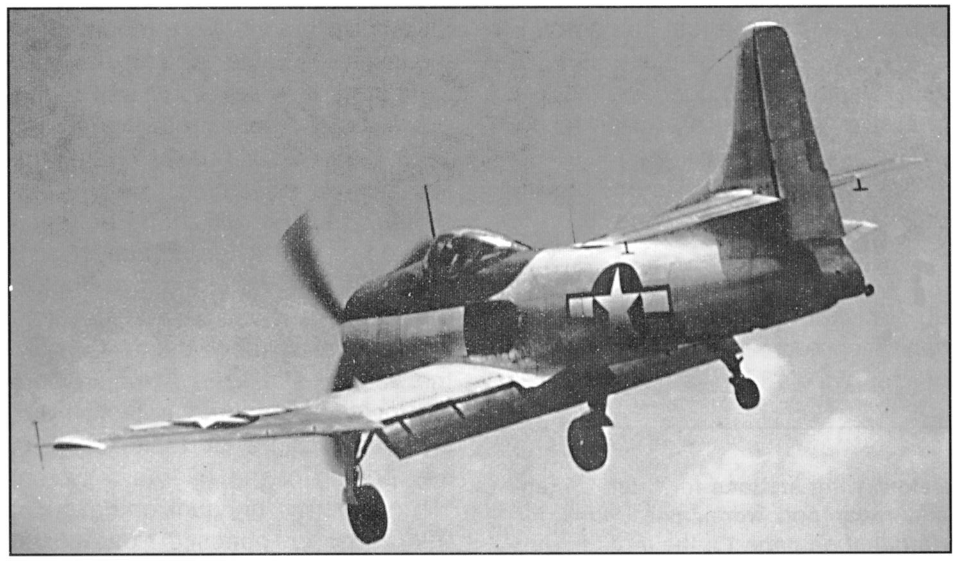
The flight control installed on dive bombers to limit their diving speed was the dive brake. SD-367 stipulated that with the XBTK-1 in its "design configuration" (1,000 lb bomb and take-off gross weight of 14,881 lbs) or at its "design gross weight" (14,300 lbs), its dive brake must be capable of maintaining but not exceeding a dive speed of 310 mph IAS in a 70° dive at 20% rated power. The difference in gross weights between "design configuration" and "design gross weight"

Below, landing flaps extended with the center fuselage flap retracted. (USN)

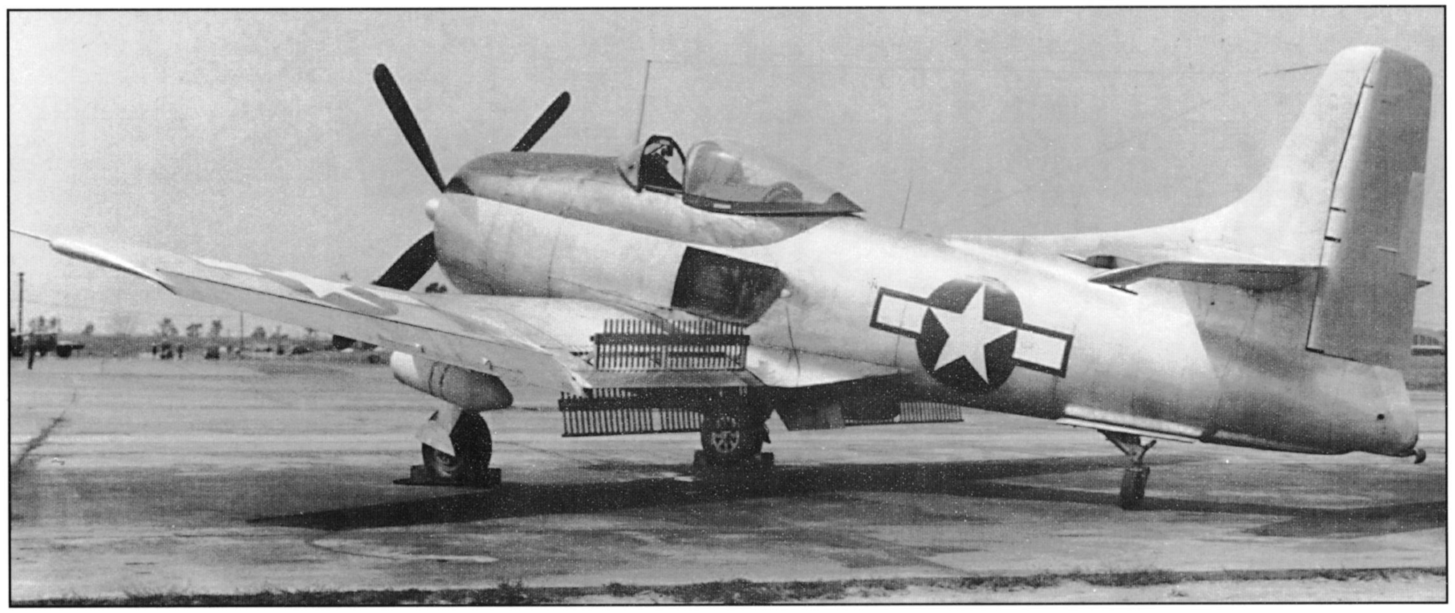


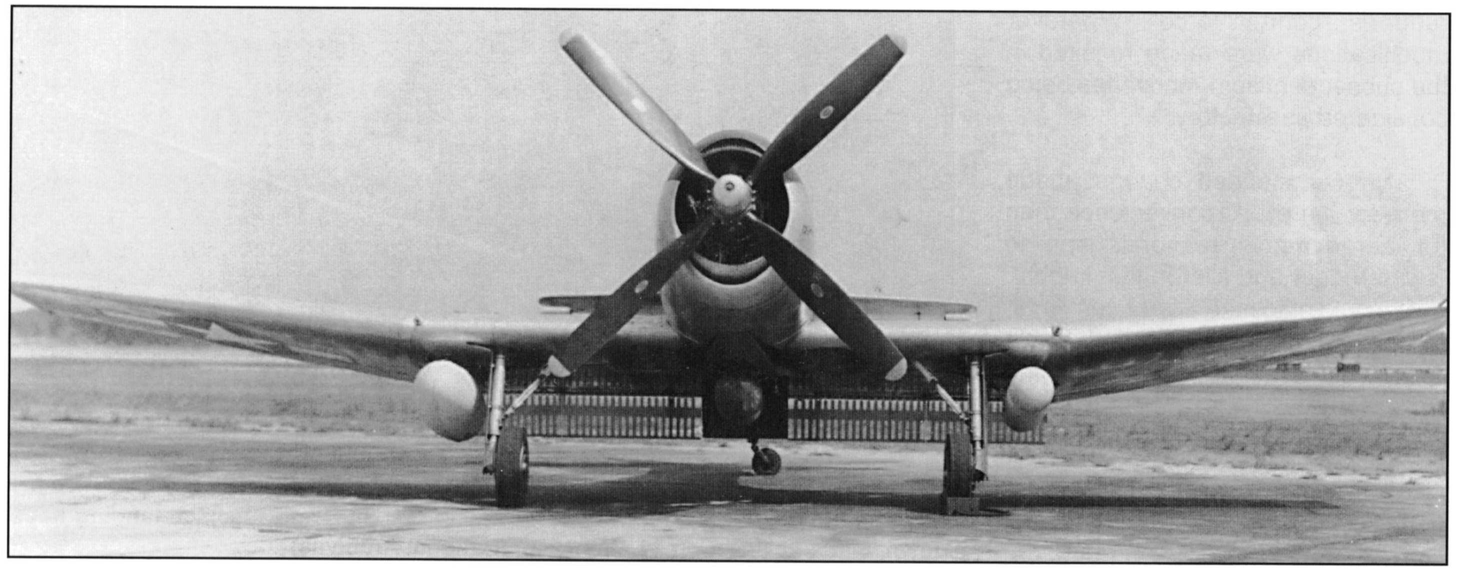


Above and below, XBTK-1 BuNo 44313, with the wing and fuselage landing flaps down, lands at NATC on 21 May 1946. (National Archives)



Below, XBTK-1 BuNo 44313 at NATC on 13 September 1945 with upper and lower dive brakes deployed along with the center fuselage landing flap. A white radar unit is mounted under the left wing. The aircraft was natural metal with black exhaust area paneling, wing walks, canopy framing and large anti-glare panel. (USN)





Above, head-on view of XBTK-1 on 13 September 1945 with dive brakes deployed as well as the center fuselage landing flap. The aircraft is configured for the basic dive bomber mission with a 500 lb bomb on the centerline and a drop tank on one wing and a radar pod on the other. The aircraft is fitted with a Hamilton Standard propeller. (USN)

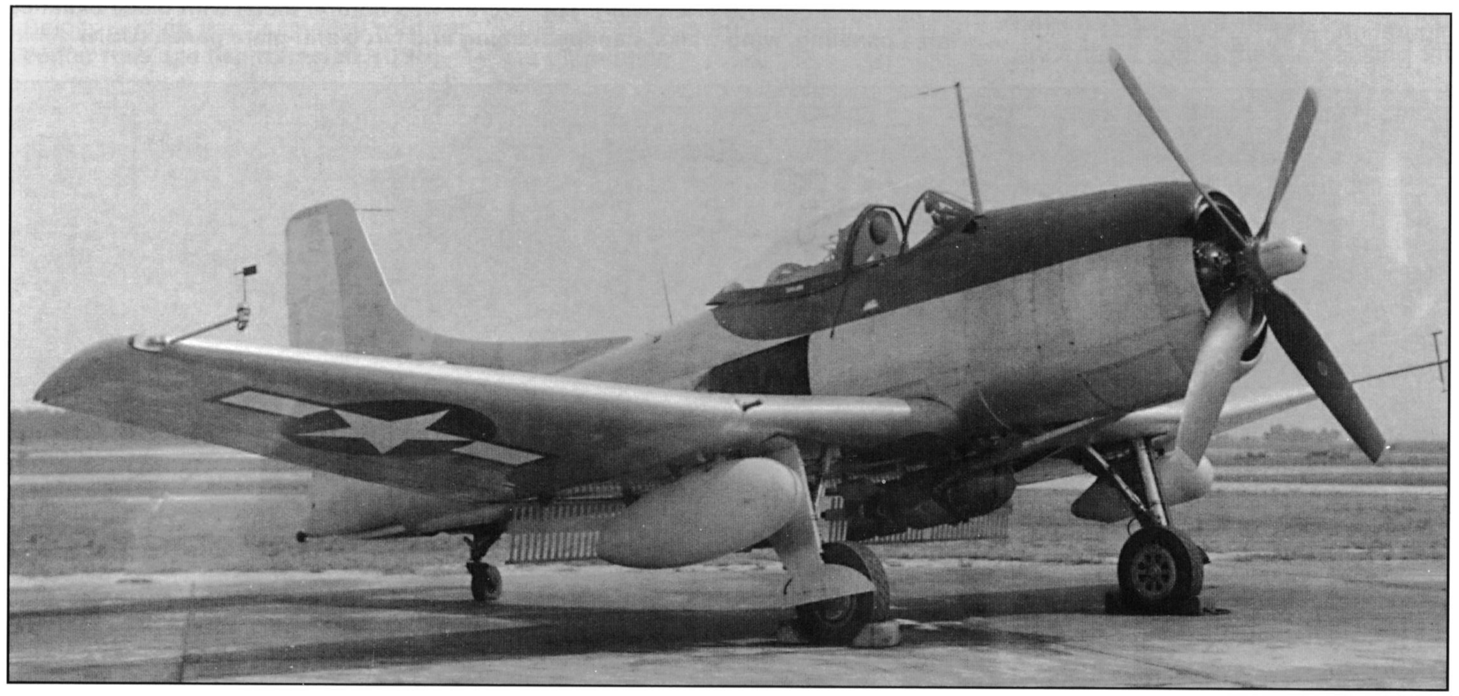
is the weight of the fuel burned-off in flying to the point of attack. SD-367 also "desired" that the dive brake's operating mechanism provide for full opening at 400 mph at an altitude of 14,000 feet in 2-seconds and closing at 310 mph IAS in 1-second.

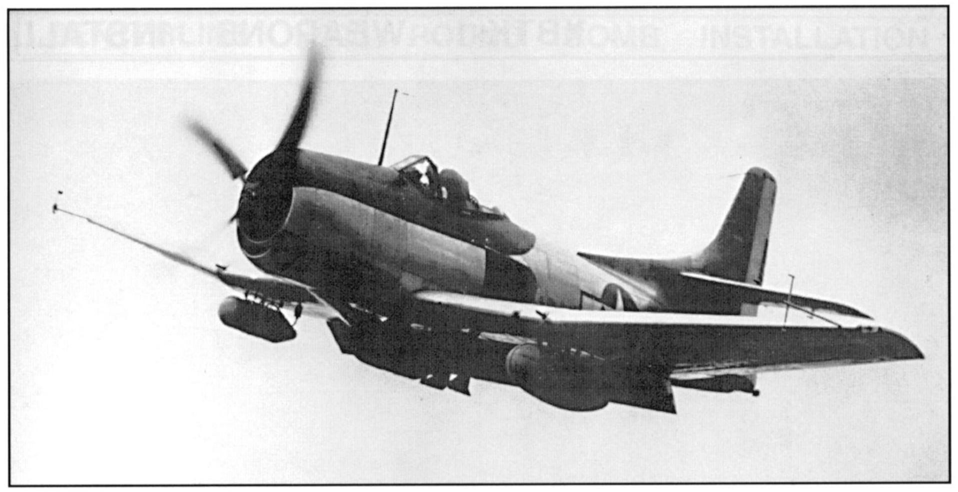
The XBTK-1's dive brake consisted of picket fence or finger type sections mounted on the top and bottom of the wing's center section. The lower dive brakes were mounted on the surface of the landing flap and split from it when used as a dive brake, but extended with the landing flap to form a solid panel when landing flaps were selected.

To help avoid the buffeting caused by the disturbed airflow generated by wing-mounted dive brakes, the horizontal stabilizer and elevators were mounted above the fuselage on the vertical stabilizer. A requirement to provide asymmetric protection was included: "failure or malfunction of any portion of the hydraulic system will not permit unequal operation of the brakes on opposite sides of the airplane". This dive brake system reduced "aileron forces below those encountered in an unbraked dive", conditionally offsetting that previously mentioned aileron deficiency. Although not without need for refinement, the dive brake system enabled the XBTK-1 to demonstrate diving characteristics that were reported as "superior to contemporary dive-bombers" during the Preliminary Evaluation.

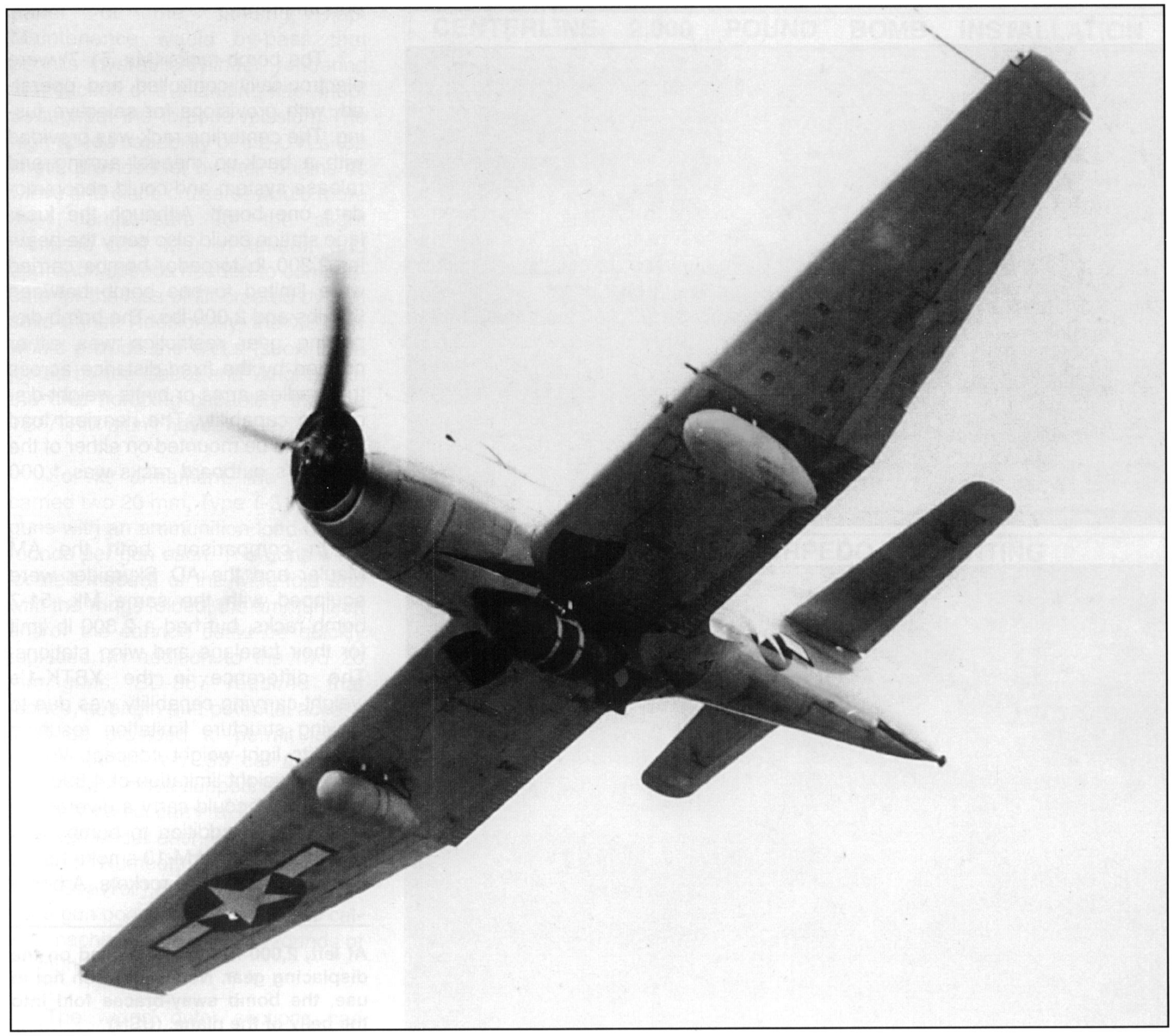
A device that was a necessity to the propeller driven dive bomber was the bomb displacing gear that positioned its fuselage-mounted bomb clear of the propeller's arc before releasing it during a steep dive (dive angle greater than 45°). Although the XBTK-1's bomb displacing gear has escaped the attention of aviation historians, it was advanced in its use of an aerodynamically-shaped cradle that retracted to stow flush with the airplane's contours when not loaded. The treatment for the three bomb racks was similar in drag-reducing

Below, wing stations for the drop tank and radar pod were interchangeable. Note that on page 15, the in-flight photos show the pods reversed from those on this page. (USN)

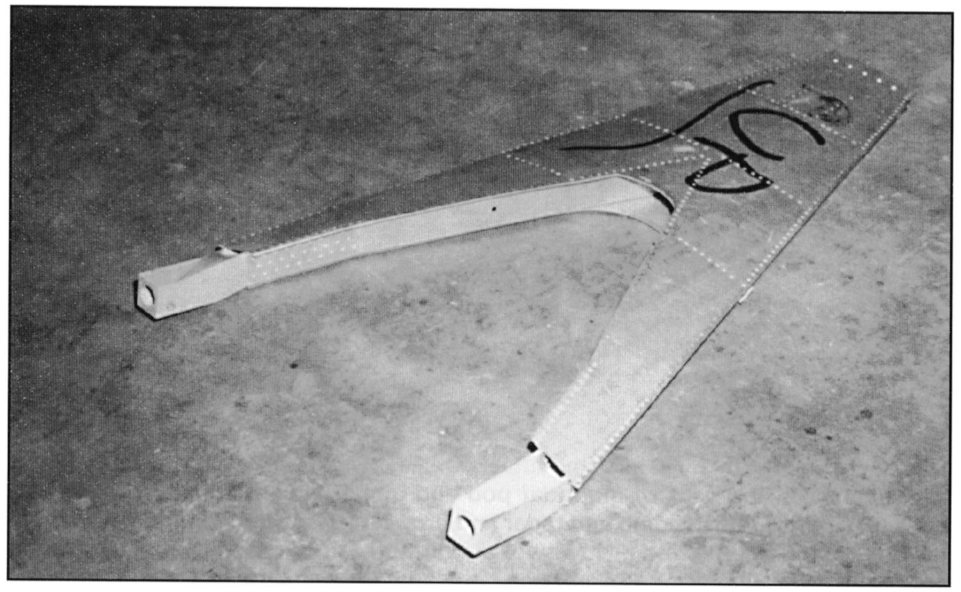


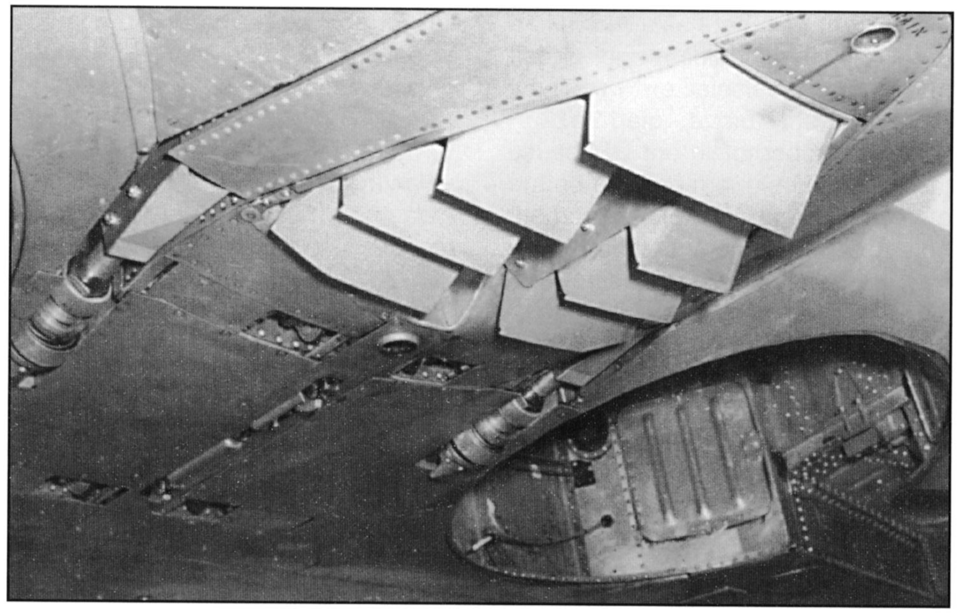


Above, in flight with 1,000 lb bomb attached. Note electrical cannon type plug and wiring seen off the back of the radar pod and going into the wing above. Below, belly view with 1,000 lb bomb and radar and drop tank installed. (National Archives)



XBTK-1 WEAPONS INSTALLATIONS



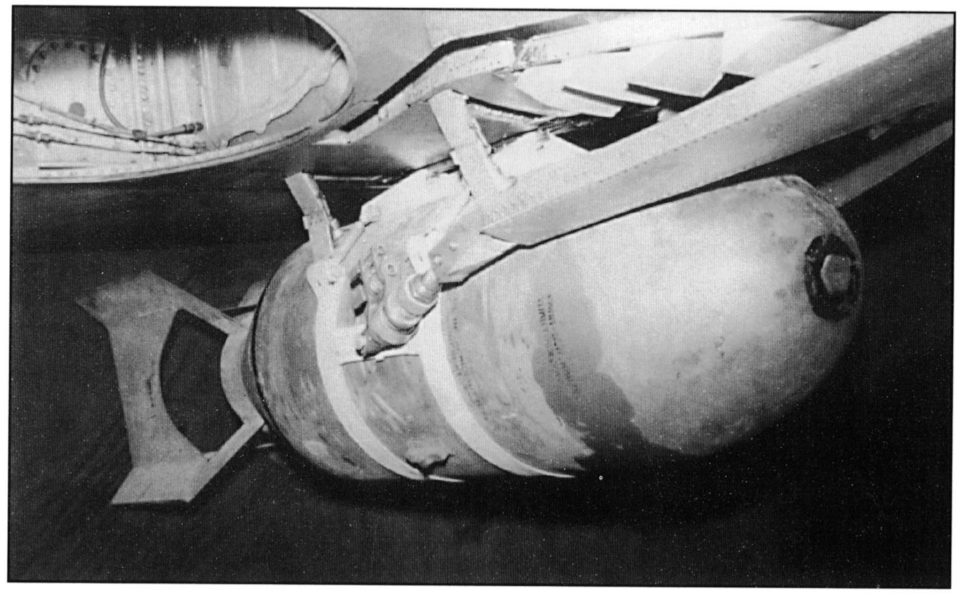


At left, XBTK-1 aerodynamically-shaped bomb displacing arm. (National Archives) At left middle, flush fitting bomb displacing gear in place. The duct flaps located in the center of the "V' of the displacing gear were the oil cooler exit air cooling duct flaps. (National Archives)

concept, all being installed within their structures and equipped with retractable sway braces. This complied with SD-367's requirement to "be so installed that they will offer the least wind resistance". This, along with the XBTK-1's many weight-saving measures, speaks well of the Fleetwings' design team's efforts to maximize its performance.

The bomb racks (Mk. 51-7) were electronically controlled and operated, with provisions for selective fusing. The centerline rack was provided with a back-up manual arming and release system and could accommodate one bomb. Although the fuselage station could also carry the heavier 2,200 lb torpedo, bombs carried were limited to one bomb between 500 lbs and 2,000 lbs. The bomb displacing gear restriction was either created by the fixed-distance across the cradle's arms or by its weight-displacing capability. The heaviest load that could be mounted on either of the XBTK-1's outboard racks was 1,000 pounds.

In comparison, both the AM Mauler and the AD Skyraider were equipped with the same Mk. 51-7 bomb racks, but had a 2,300 lb limit for their fuselage and wing stations. The difference in the XBTK-1's weight-carrying capability was due to a wing structure limitation resulting from its light-weight concept. Within its total weight limitation of 4,890 lbs, the XBTK-1 could carry a diversity of loads that in addition to bombs and torpedos included M-10 smoke tanks, depth charges, and rockets. A bomb rack control unit used by the ordnancemen during loading was accessed through a panel located in the starboard wheel well.



At left, 2,000 lb bomb installed on the displacing gear. Note that when not in use, the bomb sway-braces fold into the belly of the plane. (USN)

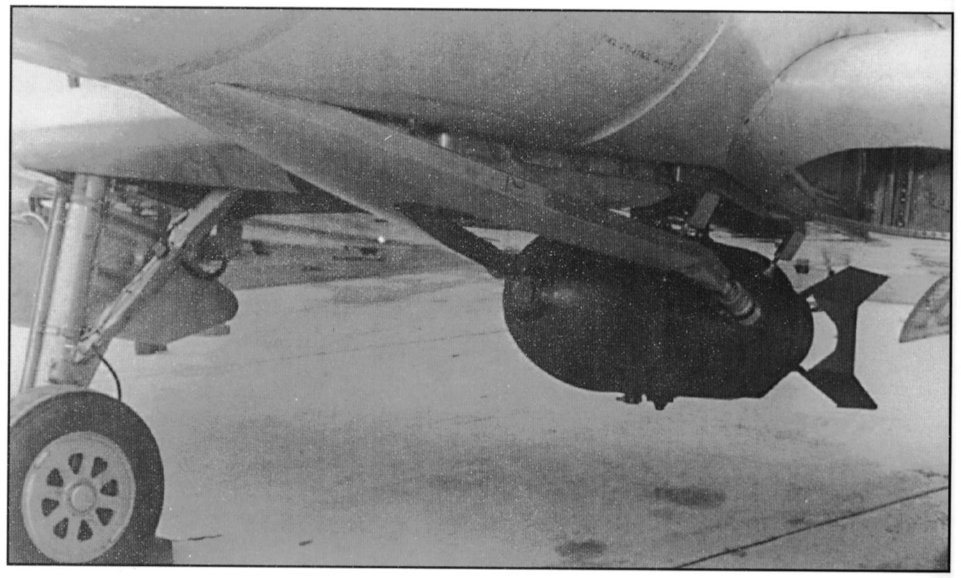
The aircraft designation change to XBTK-1 from XBK-1 indicated that the design's development included its possible replacement of the TBF/TBMs operating from the Independence class of light carriers. The relevance of those light carriers is also shown by the 1944 invasion of Leyte. Of the sixteen carriers that formed the Fast Carrier Force of Task Force 38, eight were CVLs.

When carried for torpedo bomber missions, the 2,200 pound torpedo extended aft to overlap the solid panel of the landing flap. Maintenance would by-pass that panel's hydraulic-cylinder rendering that section of the landing flap "inop" throughout the torpedo mission. The high speed capability of the CVLs (32 knots, provided for by their origins as Cleveland class cruisers) would more than compensate for the slight increase (2-4 kts) in takeoff and approach speeds needed to compensate for the loss of lift created by that solid panel. Additionally, the XBTK-1 would provide the CVLs (soon to be joined by the Cabot and Wright) with the dive bombing capability that the TBF/TBM didn't have.

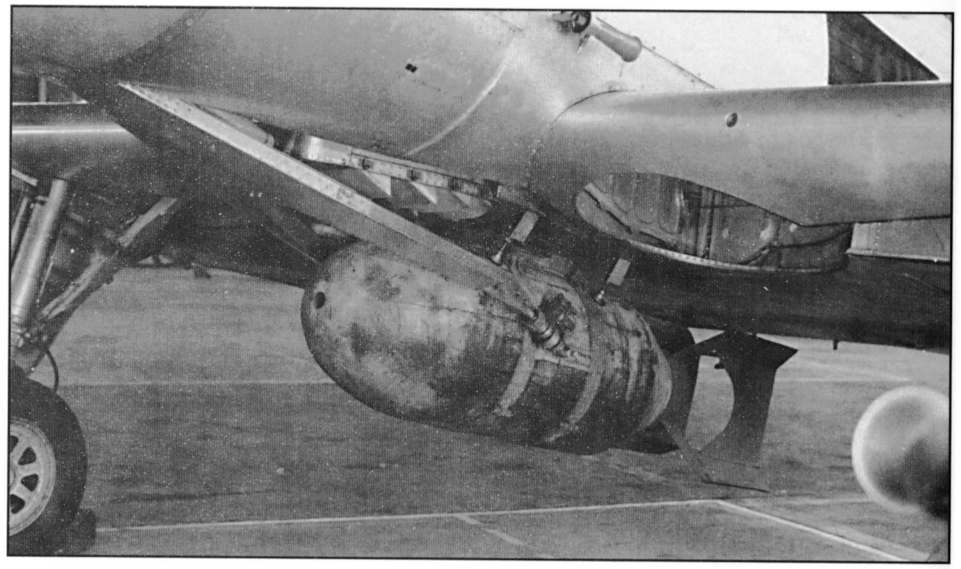
For its armament, the XBTK-1 carried two 20 mm, Type T-31 aircraft guns with an ammunition load of 200 rounds per gun each. The guns were located inboard of the wing-fold and with the wings folded, the ammunition and/or the cannon could be quickly replaced. In addition to the two 20 mm guns, SD-367 required that "space, strength and potential access shall be provided to permit future installation of two .50 cal machine guns". As a close support aircraft the XBTK-1 could carry a Douglas gun package under each wing (see Naval Fighters Number Thirty-Three, The TBY SeaWolf).Each of these packaged gun pods contained two .50 caliber machine guns with 350 rounds of ammunition per gun.

The wings' outer sections had

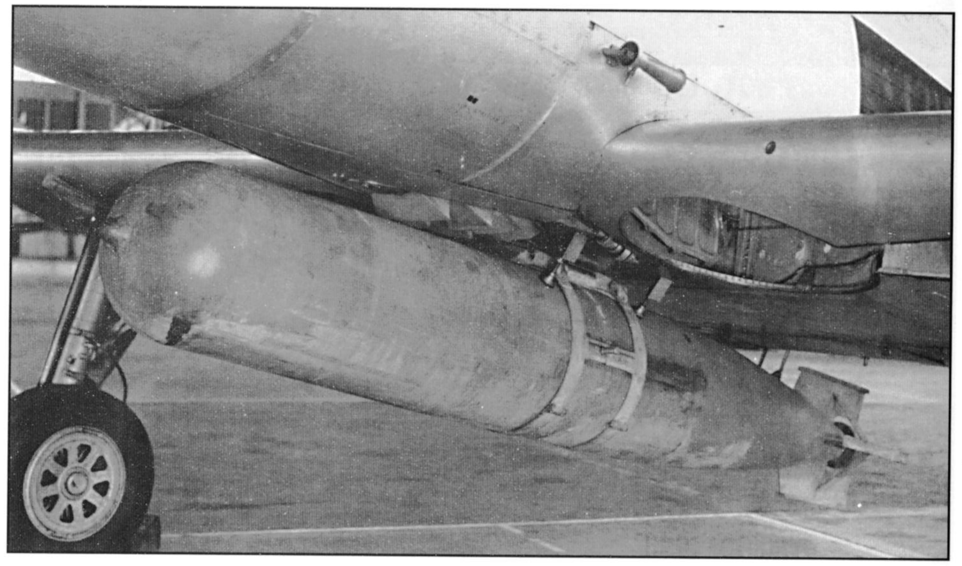
CENTERLINE 1,000 POUND BOMB INSTALLATION



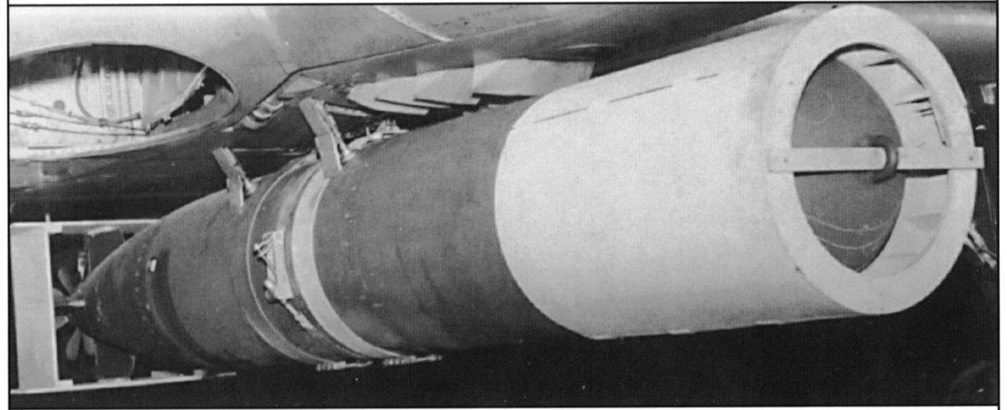
CENTERLINE 2,000 POUND BOMB INSTALLATION



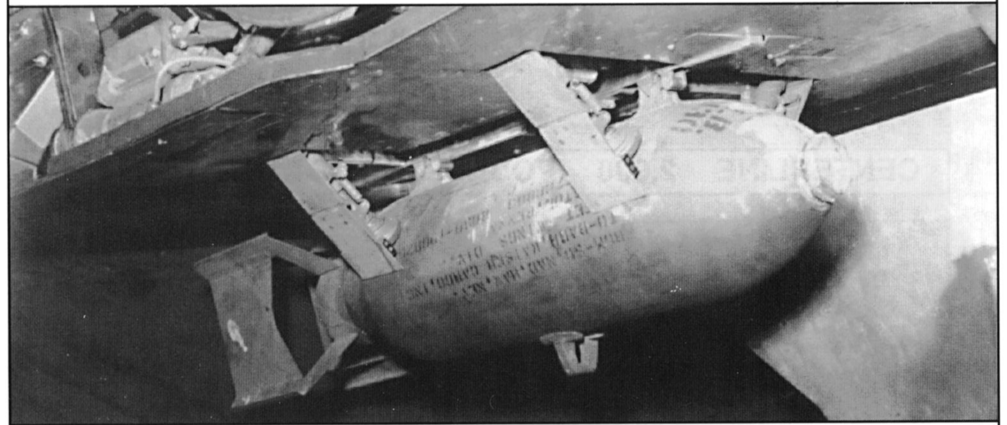
2,200 POUND TORPEDO MOUNTING



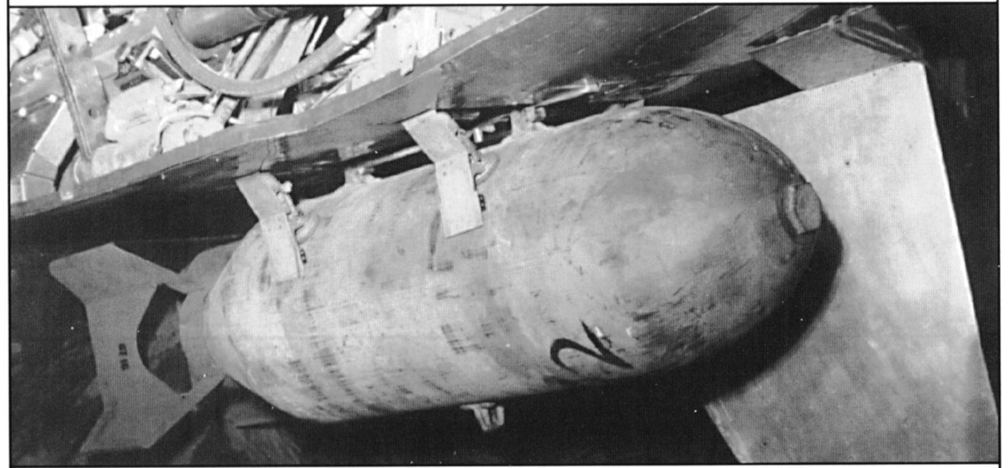
MK-13 TORPEDO INSTALLATION



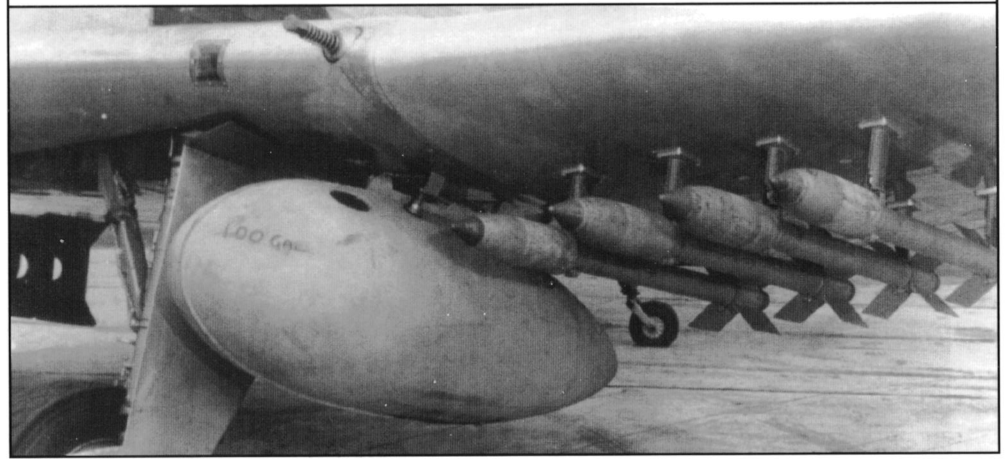
100 POUND BOMB WING INSTALLATION



500 POUND BOMB WING INSTALLATION



80 POUND ROCKET INSTALLATION



At left, the square area around the aft end of the torpedo was a wooden box used to protect the torpedo's rudder and prop from damage up until mission time. Similarly, the forward end of the torpedo was protected prior to flight as shown here. (National Archives)

At left below, two photos of wing-mounted bombs, which show the self-contained bomb sway braces which when not in use fold flush into the wing's surface. (National Archives)

At right, wing cannon in the detached position so that the ammo box can be removed. Once unlatched, the cannon was folded down and outward. The photo also offers a good view of the outer wing rib and wing-fold mechanism. Also note mounting gear for the radar pod. (National Archives)

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provisions for eight zero length rocket launchers that could carry either the 34 lb 3.5-inch or the 80 lb 5.0-inch aircraft rocket. The wings had the structural strength to support the future installation of the 130 lb 5.0-inch High Velocity Aircraft Rocket (HVAR) then under development.

A Mk. 8 illuminated sight was installed above the instrument panel. It projected its reticle's image onto the bullet resistant glass panel of the windscreen and along with a backup optical ring sight served as either the gun sight, bomb sight or torpedo director. A windshield de-fogging system was needed to compensate for the quick temperature changes encountered during a diving attack. It was controlled by a knob

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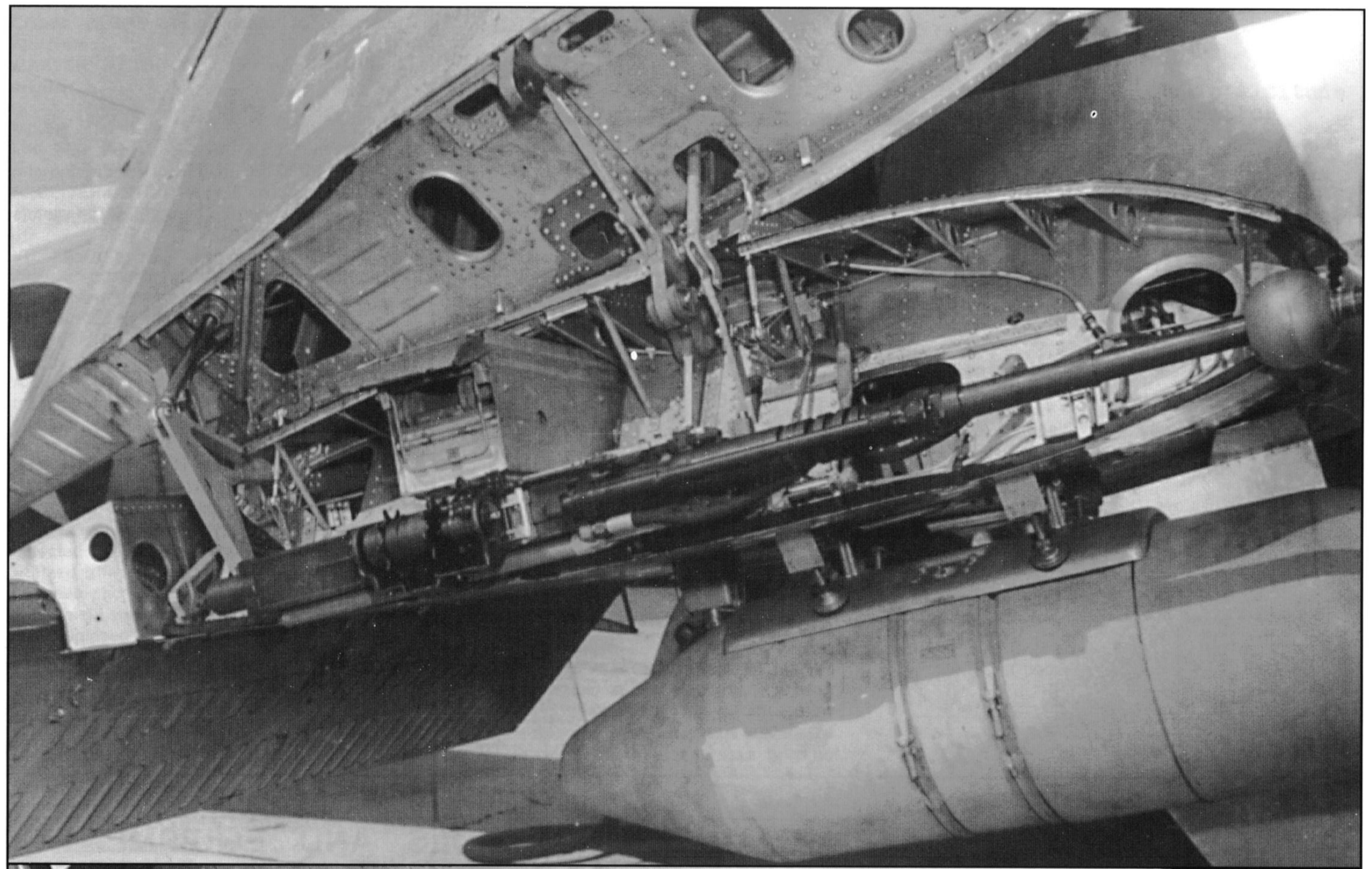
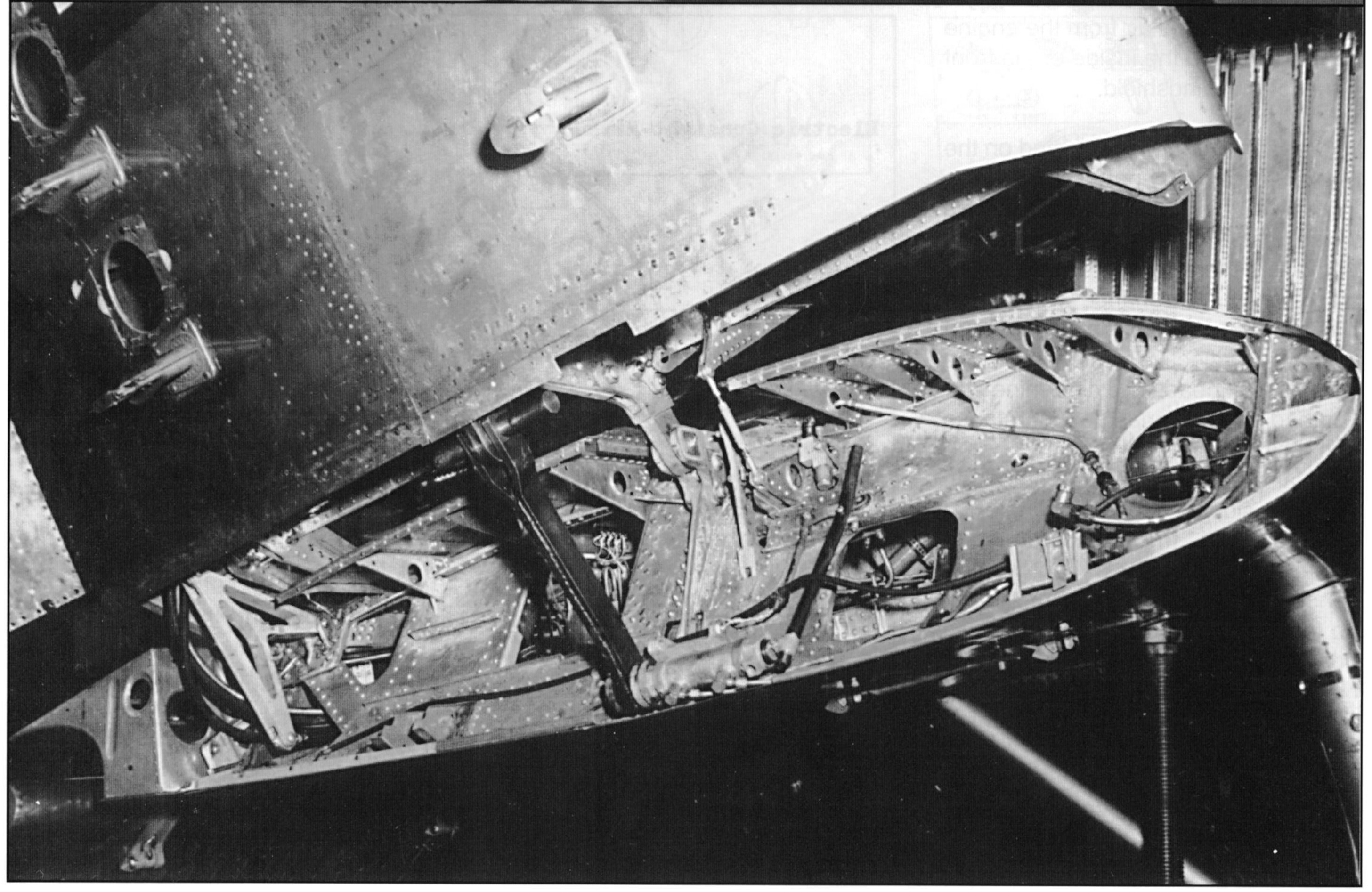
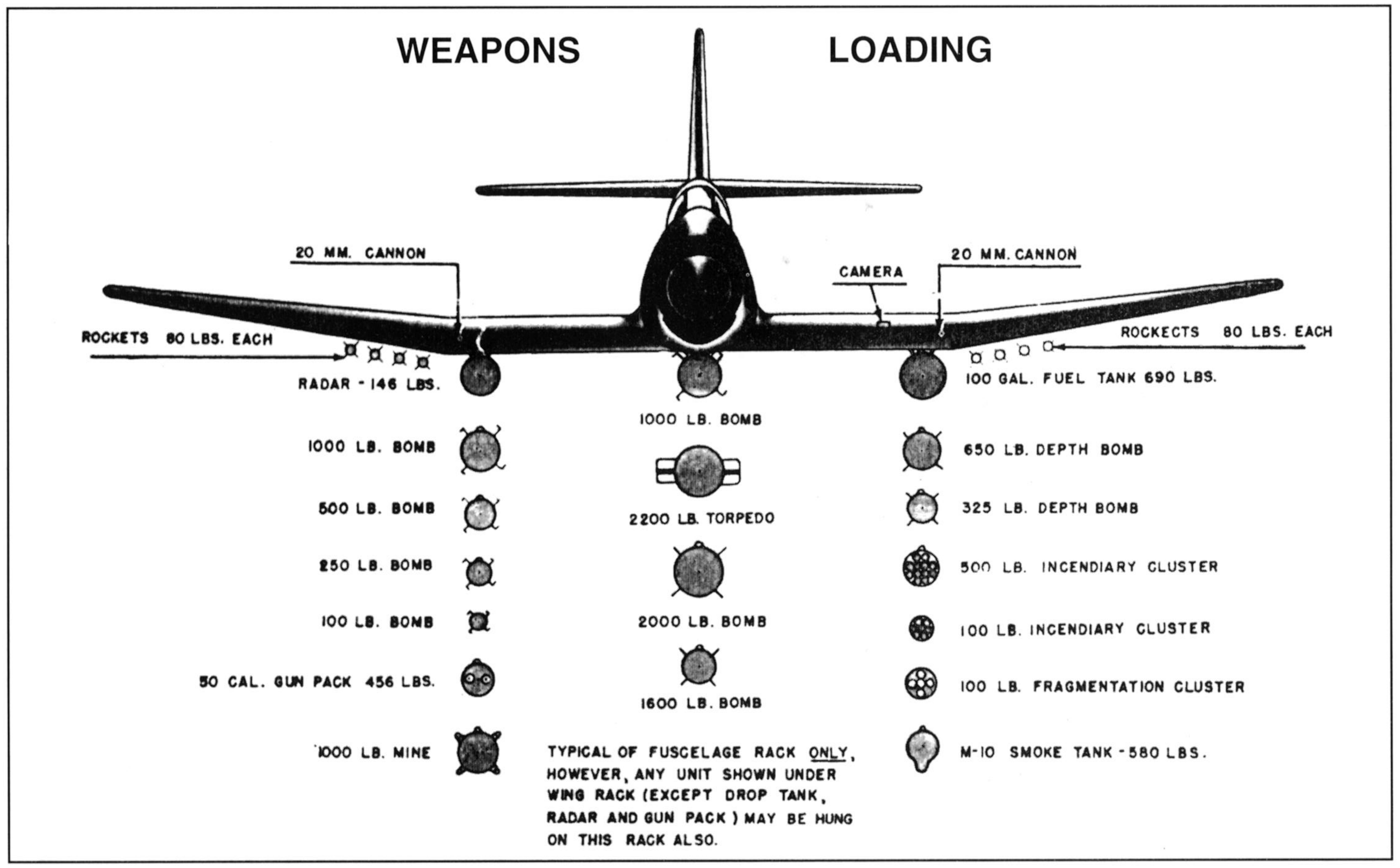
At left, a 100 gallon fuel tank and four 80 pound aircraft rockets are mounted on the XBTK-1's wing on 4 August 1945. (National Archives)

At right, inboard wing-fold rib and folding mechanism seen with the 20 mm gun and ammo can removed. Note the rocket launcher stubs on the lower wing. (National Archives)

WING - FOLD AND WING - GUN INSTALLATION



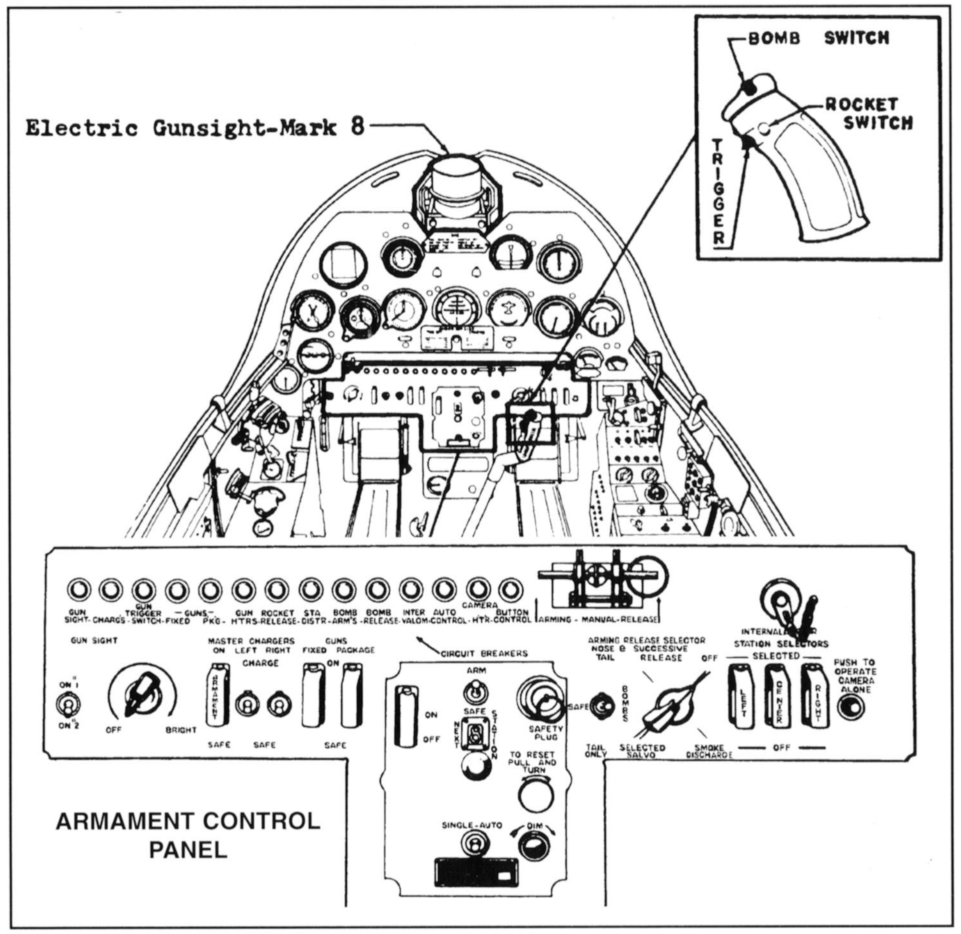



WEAPONS LOADING
20 MM. CANNON
CAMERA
20 MM. CANNON
ROCKETS 80 LBS. EACH
ROCKETS 80 LBS. EACH
RADAR - 146 LBS.
100 GAL. FUEL TANK 690 LBS.
1000 LB. BOMB
1000 LB. BOMB
650 LB. DEPTH BOMB
500 LB. BOMB
2200 LB. TORPEDO
325 LB. DEPTH BOMB
250 LB. BOMB
500 LB. INCENDIARY CLUSTER
100 LB. BOMB
2000 LB. BOMB
100 LB. INCENDIARY CLUSTER
50 CAL. GUN PACK 456 LBS.
1600 LB. BOMB
100 LB. FRAGMENTATION CLUSTER
1000 LB. MINE
TYPICAL OF FUSELAGE RACK ONLY, HOWEVER, ANY UNIT SHOWN UNDER WING RACK (EXCEPT DROP TANK, RADAR AND GUN PACK) MAY BE HUNG ON THIS RACK ALSO.
M-10 SMOKE TANK - 580 LBS.

on the right side of the main instrument panel. When selected, this system routed heated air from the engine compartment to the inside of the front panel of the windshield.

All armament was selected on the armament switch panel below the instrument panel. The gun switches were located on the left side and the bomb torpedo switches were located on the right. All ordnance was fired or released electrically by the use of individual, selective switches on the control stick head. The centerline station had an additional manual release capability controlled by the bomb Manual Release handle located on the right-side of the cockpit floor at the base of the radio console. Recalling the airplane's "light weight" concept, the pilot was without either an ammunition counter or a bomb position indicator. A gun camera (AN-N6A) was installed in the left-wing centersection and was controlled from the armament panel.

ARMAMENT CONTROLS AND EQUIPMENT



The radio console was located on the right side of the cockpit and contained the controls for the following transmitters and receivers:

MASTER
COMM VOLUME: Volume control for selected receivers.
MASTER Switch: Turn ON after starting engine.

MIXER
MIC SEL: For either VHF or HF transmitter, microphone key located on top of the throttle
RECEIVER OUTPUT Toggle switches (2): For either or both VHF and HF receivers.

VHF
AN/ARC-1: 4-channel, two way voice communications in VHF range. Used the whip antenna mounted aft of the pilot's canopy.

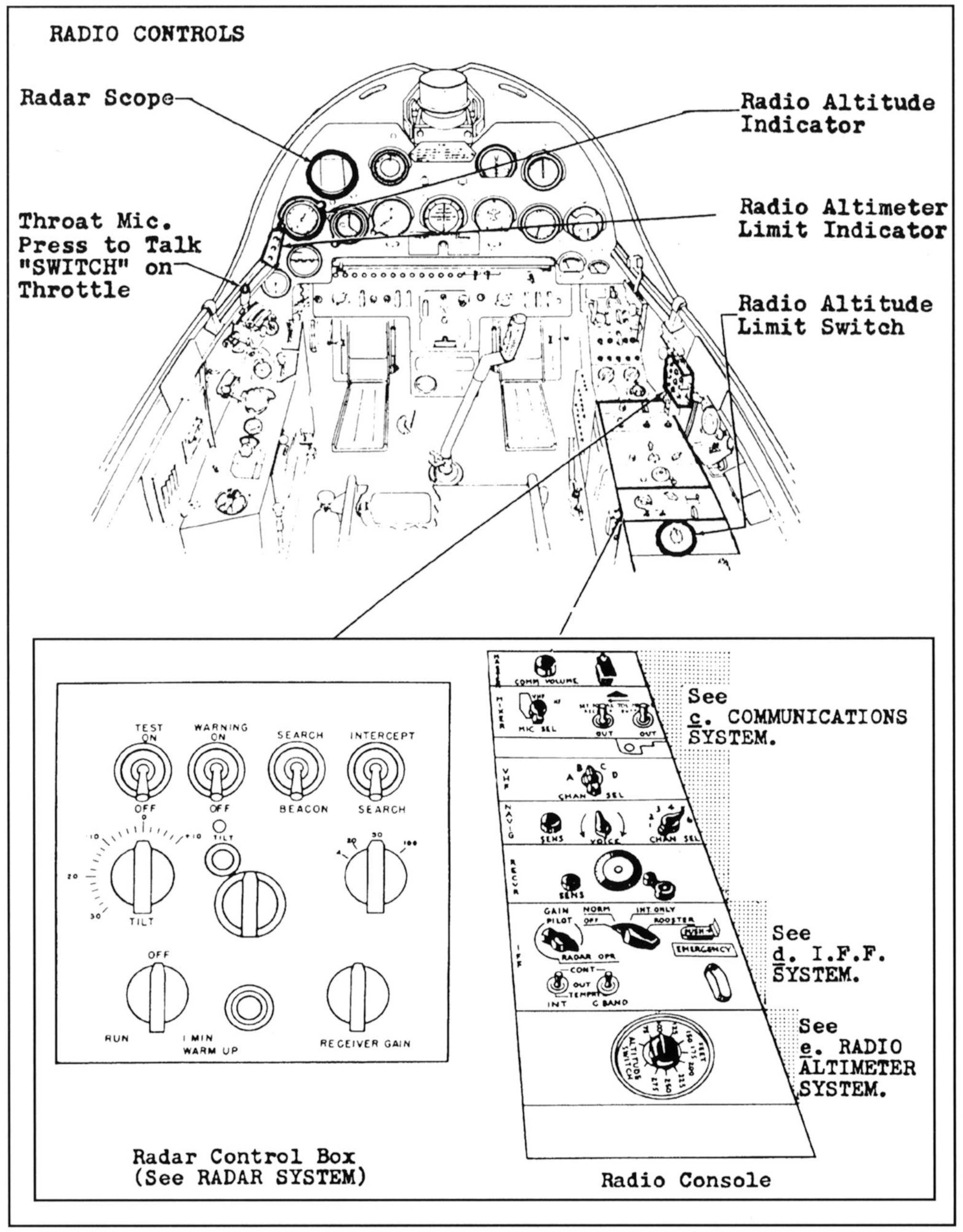
NAVIG
AN/ARR-2: ZB receiver for ships YE homing transmitter. Range is listed as "line of sight", meaning that YE frequency was in the VHF range.

RECVR
AN/ARC-5: High Frequency voice communications with a range of 150 miles. Frequency selected by vernier scale "coffee grinder", utilized the antenna wire that extended between the mast located forward of the windshield and the top vertical stabilizer. This unit replaced by a Low Frequency range receiver to serve as the navigational aid for ferry flights.

IFF
AN/APX-2: Identification Friend or Foe Transponder
NORMAL: Be identified as friendly by appropriately equipped forces.
INT ONLY: Transmitted a "blossom" to allow positive identification.
ROOSTER: Transmitted a continuous and amplified "blossom" reserved for emergency use.
PUSH: Removed mechanical guard to allow access to the emergency switch.
EMERGENCY: Used to destroy equipment in case of imminent capture.

RADIO ALTIMETER
AN/APN-1: Selector controlled the altitude that would illuminate the Radio Altimeter Limit Indicator lights located on the left side of the instrument panel. The antenna used were mounted on the undersides of the horizontal stabilizer.

RADIO CONTROLS



The Pioneer P-2 autopilot provided was an electrically-operated, rudder-only autopilot which controlled the airplane in automatic flight directionally through the gyro flux gate compass as shown on the master direction indicator (MDI), and its rate of turn through the turn and bank indicator. This single-axis auto pilot was specified perhaps to take advantage of its being lighter-in-weight than the three-axis, P-1 auto pilot that equipped the AD. The auto pilot control panel was located forward of the radio console and contained the combination controller and turn knob with the following positions:

CAGE
Cages the gyro flux gate compass (MDI) and gyro horizon (attitude gyro indicator) when maneuvers are likely to exceed 70° pitch and/or 110° bank to prevent their damage.

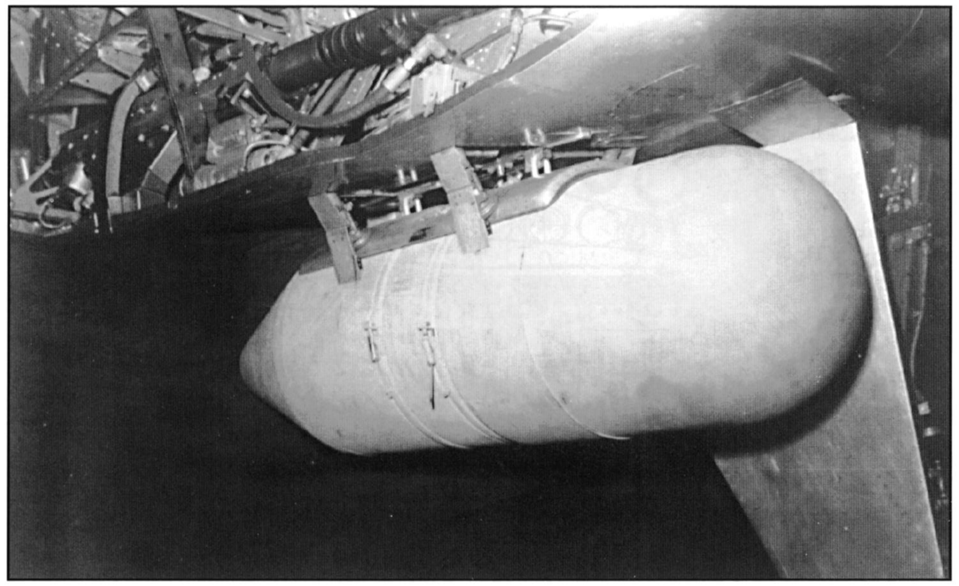
OFF
Gyros are uncaged and useable, electrical power is not provided to the auto pilot circuit.

POWER
Electrical power is provided to the auto pilot amplifier and used to provide the required, two minute warm up period.

ON
Electric power is provided to the auto pilot servo control which then, through the "power clutch", allowed the auto pilot to control airplane heading.

In normal flight, the pilot would use the autopilot trim knob to select the desired magnetic heading while continuing to "fly" the ailerons and elevator. The aileron and horizontal stabilizer could be trimmed normally but the pilot would need to disengage the auto pilot to retrim the rudder. This need to retrim was a limitation created by the use of vacuum-tubes which would be reflected in the handbook: "Generally, when using the automatic pilot, the airplane should be retrimmed in manual flight every hour". A floor-mounted disengagement handle to the "power clutch" served as the emergency disconnect.

AN/APS-4 SEARCH RADAR



At left, RT-5A/APS-4 radar receiver/transmitter installation under the wing of an XBTK-1. (National Archives)

The XBTK-1 was equipped with the AN/APS-4 radar for its search equipment. The pilot's controls included the control unit mounted on the right-hand side of the cockpit, and the APS-4 indicator screen with rectangular display was mounted on the upper-left instrument panel.

The radio equipment was located within the fuselage, aft of the wing. Access was provided through a door on the underside of the fuselage.

The oxygen system was of the high pressure type with a maximum cylinder pressure of 1,800 pounds when fully charged. The 295 cubic inch capacity cylinder was located to the left of the pilot's seat where its shutoff hand-wheel could readily be turned, ON or OFF. The cylinder was protected from gunfire by the pilot's armored bulkhead and could be recharged in place. A diluter-demand oxygen regulator with pressure gauge attached was located on the right side of the cockpit. In its NORMAL OXYGEN position, the regulator air valve supplied an air-oxygen mixture whose ratio would change according to the airplane's altitude, ie., from sea level, where it was pure ambient air, to 30,000 feet and higher, where the mixture was 100% oxygen. When switched to the 100% OXYGEN position, the regulator supplied 100% cylinder oxygen, regardless of the airplane's altitude. A separate Emergency Bypass Valve, located upstream of the regulator, was provided in case of regulator failure or if the pilot started to experience symptoms of anoxia.

The design specifications called

APS RADAR OPERATION

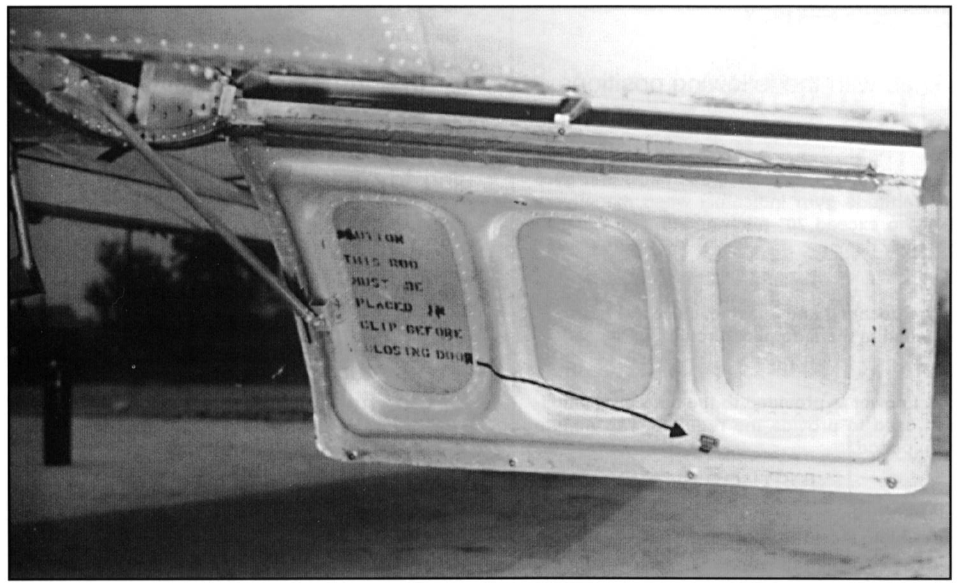
1.) Turn the "RUN -OFF - 1 MIN WARM-UP" switch to "1 MIN WARM-UP".
2.) Place the "TEST" switch to "OFF".
3.) Control and switch positions for target acquisition:

TARGETS	SEARCH/BEACON	INTERCEPT/SEARCH	RANGE	TILT
Surface	SEARCH	SEARCH	20 miles	-10
Air	SEARCH	INTERCEPT	4 miles	ZERO
Beacon Homing	BEACON	SEARCH	50 miles	ZERO

4.) "RECEIVER GAIN" control to 45° to the left of vertical.
5.) One minute after turning the "RUN - OFF - 1 MIN WARM-UP" switch to "1 MIN WARM- UP", turn to "RUN".
6.) Turn the intensity control on scope to moderately illuminate its screen.

TO TURN EQUIPMENT OFF

1.) Turn the "RUN - OFF - 1 MIN WARM-UP" switch to "OFF"'
2.) Turn intensity control (both indicators) full counterclockwise.
3.) Turn "RECEIVER-GAIN" control full counter-clockwise.



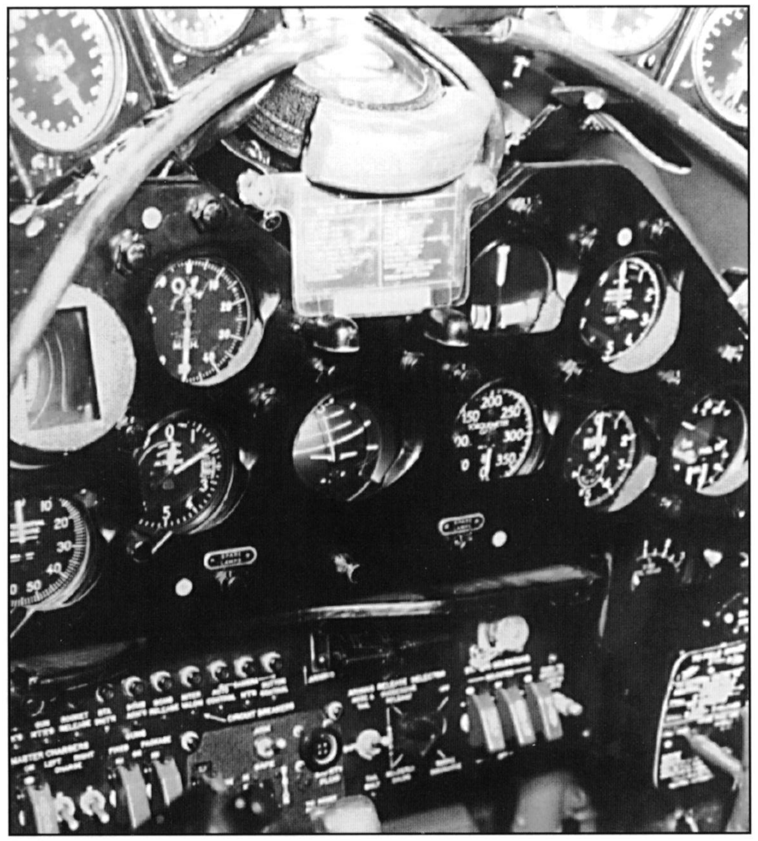
At left, radio compartment access door in the open position. The radio compartment was located in the underbelly of the fuselage aft of the wing. (National Archives)

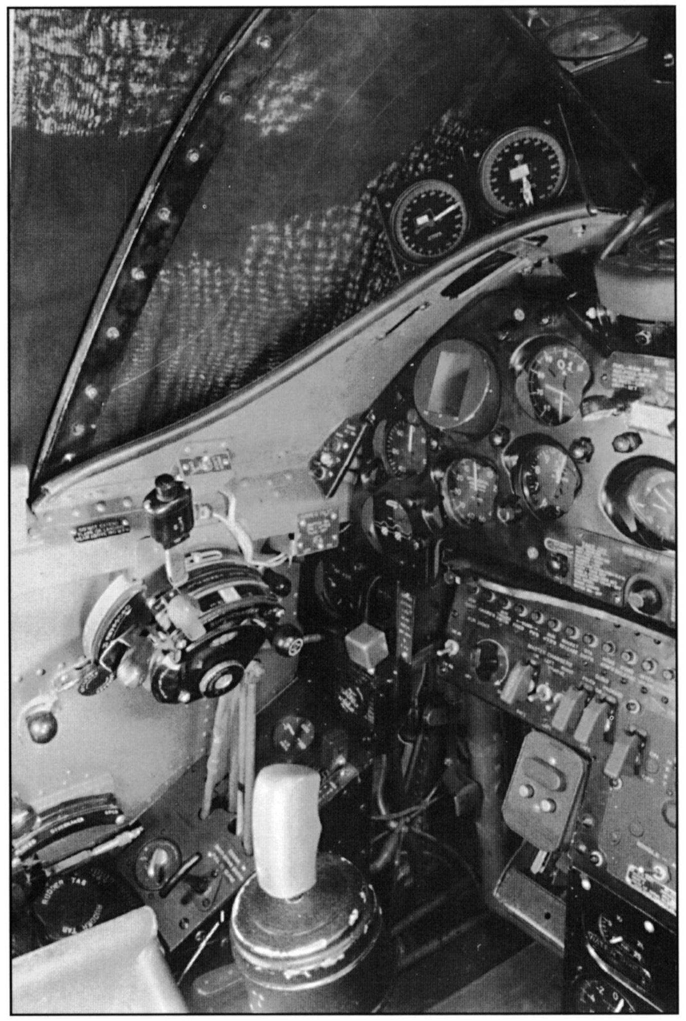
PILOT'S INSTRUMENT PANEL

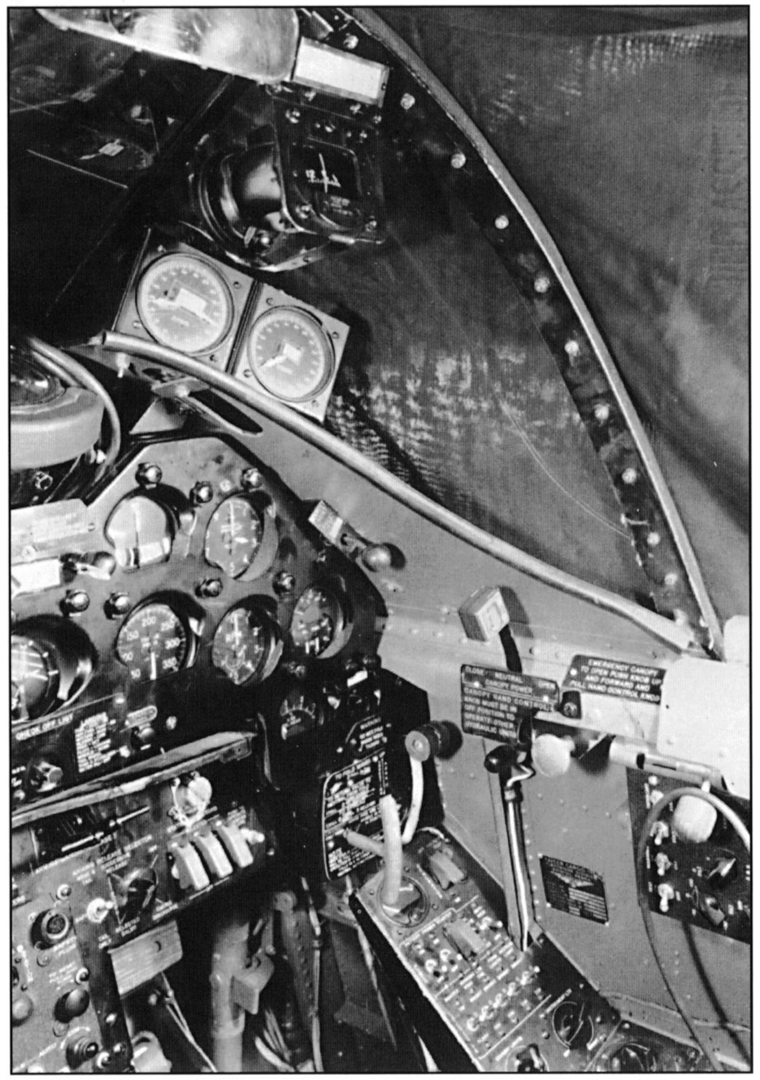
The following table indicates the oxygen duration (in hours) when the cylinder was charged to 1,800 psi:

Altitude	Normal Oxygen	100% Oxygen
10,000	5.2	0.7
15,000	4.9	0.9
20,000	4.0	1.1
25,000	2.4	1.3
30,000	1.7	1.7

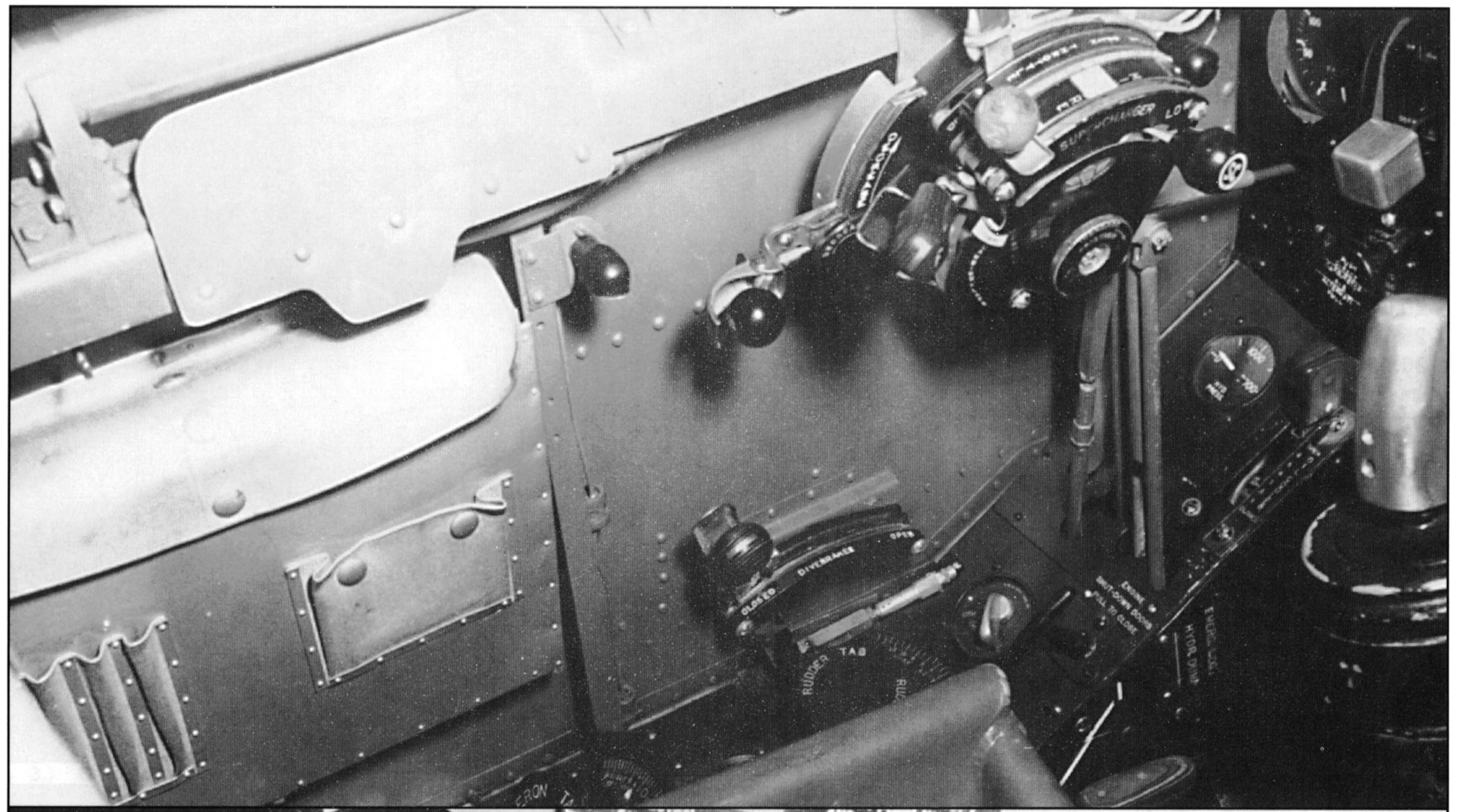
At right, the pilot's instrument panel with the radar's APS-4 indicator screen with rectangular display on the far left. The instruments mounted above the cowl lip are test instruments that would not be found on production aircraft. Below, left front and right front cockpit views of the instrument panel and the left and right forward consoles.

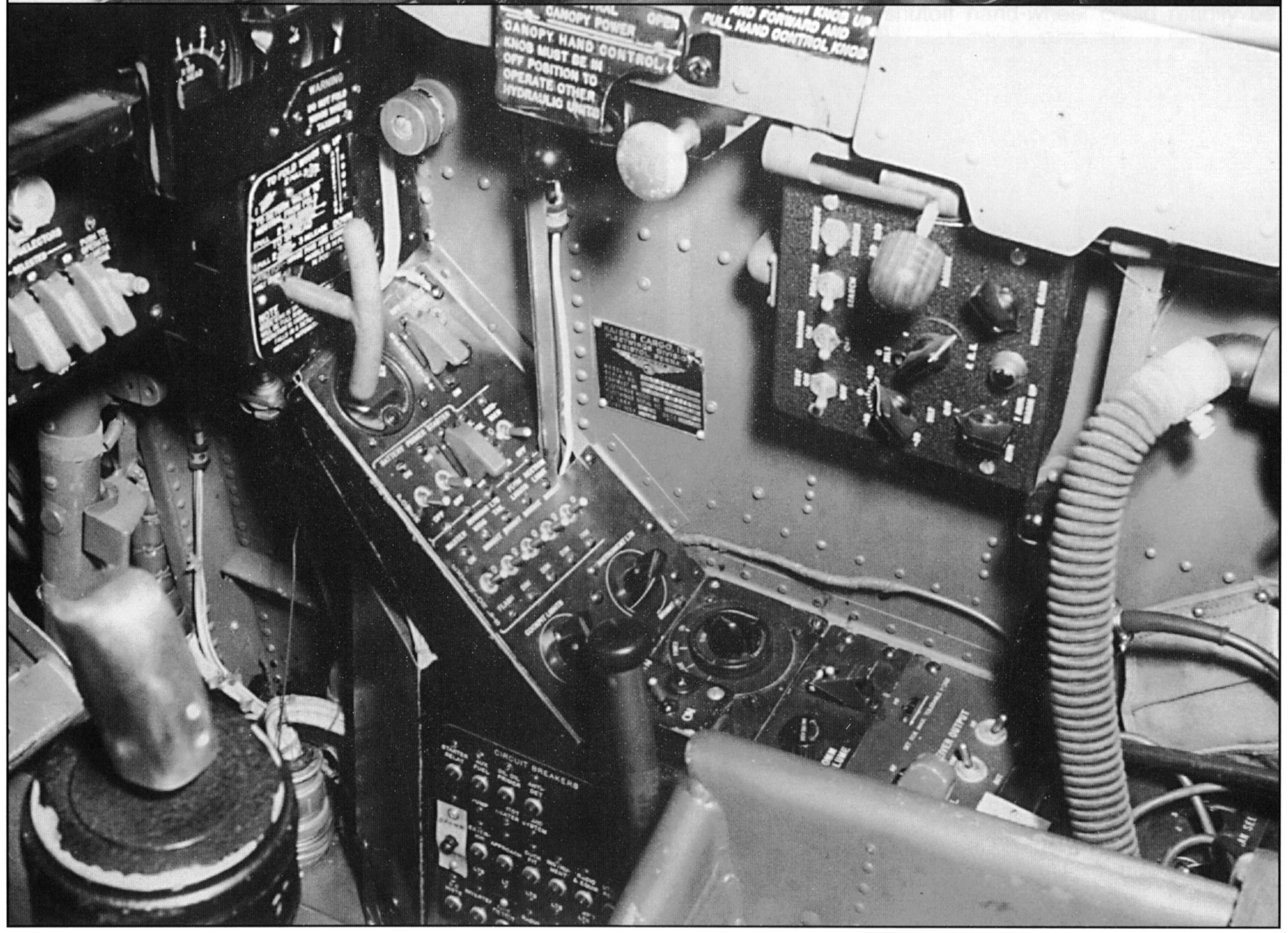






COCKPIT LEFT - HAND AND RIGHT - HAND SIDES




CANOPY POWER
OPEN
CANOPY HAND CONTROL KNOB MUST BE IN OFF POSITION TO OPERATE OTHER HYDRAULIC UNITS
CIRCUIT BREAKERS

At left, left-hand cockpit side. The large control quadrant is the engine controls while the small quadrant next to the seat contained the dive-brake and rudder controls. (National Archives)

At left bottom, right-hand cockpit side. The aircraft's circuit breaker panel is in lower portion of the photo just forward of the seat. The slanted panel is the electrical distribution panel and the upper-right control box houses the radar controls. The large "T" handle is the wing-fold control. (National Archives)

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for the installation of fire detection and CO_2 fire extinguishing systems, both manufactured to CAA (predescessar to FAA) standards. The fire detection system was a dual loop system, and had a panel for its FIRE indicator light and test buttons located beneath the armament panel. That system's logic of needing detection by both loops to activate the FIRE indicator light continues in use for aircraft fire warning systems today.

Design specifications stipulated that the amount of CO_2 specified by the CAA be considered a minimum, and that space be made available for "as much CO_2 as could be found". However, in line with the Navy's subsequent discontinuation of fire detection and extinguishing systems from this and its succeeding generations of single-engine, piston-powered airplanes, no controls for the extinguishing system have been identified nor is the system mentioned in the pilot's handbook.

For its anti-icing equipment the XBTK-1 was equipped with a pitot heater, carburetor air heat and windshield de-icing units. Taken separately, the electrical power used to heat the pitot tube and static vent was controlled by a three-position switch marked: OIL DILUTION, OFF and PITOT HEATER located next to the ANTI-ICER switch on the electrical distribution panel. Carburetor heat was controlled by a two-position, (DIRECT being full fwd and ALTERNATE full aft) push-pull rod located next to the Landing Gear control. In DIRECT, ram air was introduced to the carburetor from an inlet at the top of the engine cowling. When pulled out to ALTERNATE a carburetor header door was opened, shutting off the ram air and permitting protected warm air from behind the engine (non-ram) to enter the carburetor. The windshield de-icing system was electrically controlled by the ANTI-ICER switch on the electrical distribution panel that initiated a spray of methyl alcohol fluid, which was a 50/50 mix stored in a 1.5 gallon tank, on the outside of the windshield's front (bullet resistant) panel.

In flight, the pilot would use the Free Air Temperature gauge (BuNo 44313's Carburetor Air Temperature gauge would not be included on production models) located above the electrical distribution panel to determine when icing conditions could exist. In anticipation of encountering those conditions, the pilot's procedures entailed switching the pitot heater ON, moving the mixture control to AUTO RICH before pulling the carburetor heat control knob to ALTERNATE. The heated, non-ram air then entering the carburetor would cause a loss of manifold pressure, which in turn was automatically compensated for by the manifold pressure regulator. Although one might consider that automatic compensation a pilot-convenience, the Pilot's Handbook would caution "Warning: The normal drop in manifold pressure that occurs when the carburetor starts to ice is concealed because the manifold pressure regulator automatically opens the carburetor throttle to compensate for the loss of manifold pressure. Therefore, the pilot may receive no warning until the carburetor is heavily iced". Cold weather condition procedures also called for the use of the ALTERNATE position as both an aid in warming the engine up (before returning the carburetor heat control knob to DIRECT for take off) and when cruising, to improve fuel vaporization.

One last effect of cold weather was the need to minimize the difficulties caused by the colder, thicker oil on engine starting. For this, an oil dilution system, which introduced gas from the airplane's fuel system into the engine oil, was provided. The procedures for its use required that the engine be running at 800 RPM and involved co-ordination with maintenance to open a manual shut-off valve located in the engine accessory section while the pilot held the momentary, OIL DILUTION switch on. After four minutes, the pilot would move the mixture control to IDLE CUTOFF, and after the engine stopped turning, release the OIL DILUTION switch. Maintenance would then close and re-safety the shut off valve in preparation for the next flight. The use of oil dilution was in accordance with the following schedule:

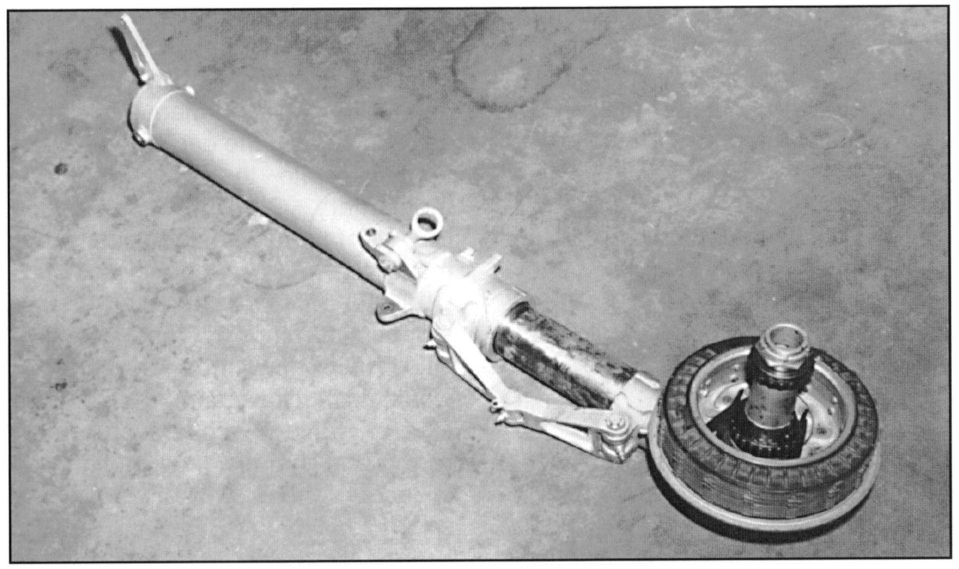
OIL GRADE	TEMP. RANGE
1100	35°F down to 0°F
1065	10°F down to 0°F

0°F and below, engine pre-heating was recommended with or without oil dilution.

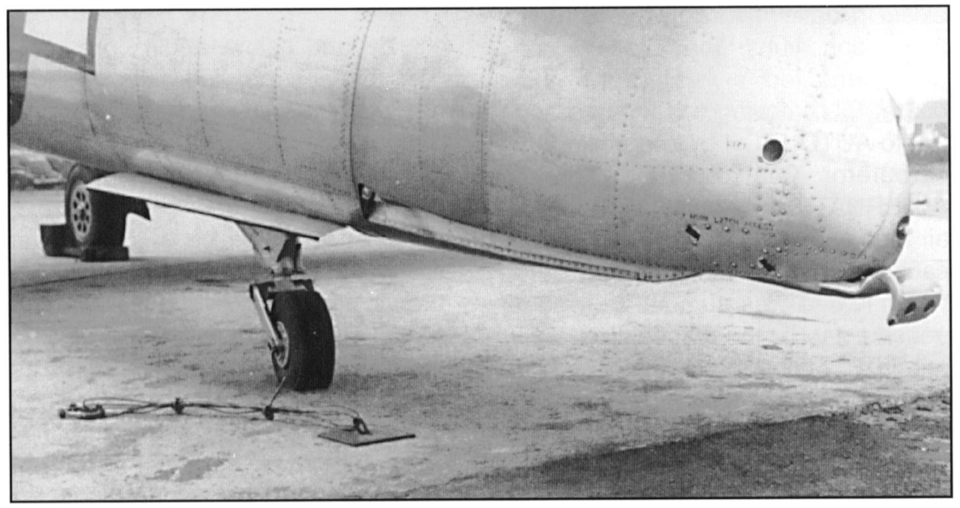
When the use of the atom bomb brought about the end of WWII, it forced an examination of what naval aviation would look like in the ensuing "atomic age". Because of that and the draconian post-war budget cuts, the money remaining for NavAir was needed for higher priority items such as jet airplane development and finding a way to deliver the atomic bomb. The Navy would also want to support those manufacturers whose aircraft were used to fight WWII as a reward for their efforts and would need to support other manufacturers who could contribute to the development of jet carrier-based aircraft. Therefore, although the XBTK-1 seemed eminently suited for the mission it was designed for. The low priority of that mission (close air support, CVE based) combined with the Navy's known disfavor of Kaiser, sowed the seeds for the termination of the design.

An agreement to finish up the flight test program was reached in May 1946, which stopped further development of the design and was quickly followed by the contract's termination on 3 September 1946. The

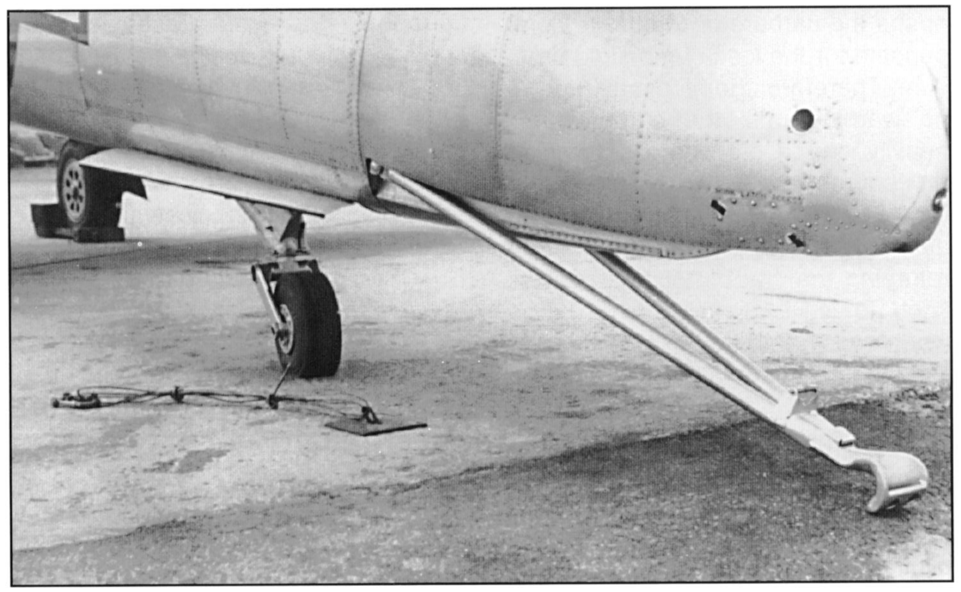
MAIN LANDING GEAR STRUT



TAIL HOOK RETRACTED



TAIL HOOK EXTENDED

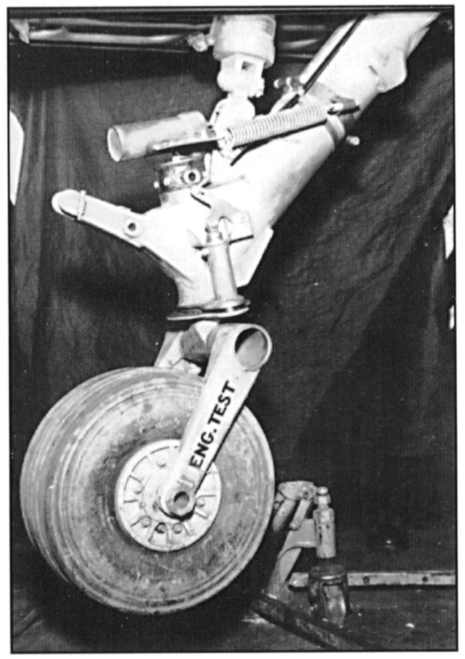


five airplanes were to be delivered for the Navy's euphemistic "research and development assignments", which in reality meant their use by aviation support facilities for tests that would result in damage and ultimate destruction. Based on the only two aircraft history cards still in existence, even that level of usage might not have been achieved.

BuNo 44314 was "accepted for service" by NAES (Naval Air Experimental Station) Philadelphia on 10 December 1947. NAES Philadelphia was a subcommand of the Naval Air Material Center (NAMC) and performed the experimental functions of the former Naval Aircraft Factory (NAF) organization. BuNo 44314 was "stricken from inventory" just four months later, on 31 March 1948.

BuNo 90486 also was "accepted for service" on 10 December 1947, but remained in an "in delivery" status until being "stricken from inventory" on 30 April 1948.

TAIL WHEEL



PERFORMANCE FIGURES AND TABLES

The following performance figures are from BuNo 44313 in its minimum drag configuration, at a gross weight of 12,965 lbs and equipped with a 13'7" Hamilton Standard Hydromatic propeller. For comparison, SD-367's estimated performance figures of the same configuration at a superficially higher gross weight of 13,014 lbs, are shown in parenthesis. Although these figures differ from each other and other published performance figures, they are offered here because these are specific to configuration and weight. They were demonstrated by BuNo 44313 during its Preliminary Evaluation. To place these figures and perhaps all such others in better perspective, the following quote from the Final Report is offered: "The following results are preliminary figures obtained from brief tests".

CALIBRATED AIRSPEED[1] @ TAKE-OFF	**72.5mph**	
TAKE-OFF DISTANCE IN A "CALM"	**470ft**	**(558ft)[2]**
TAKE-OFF DISTANCE IN A 25kt WIND	**185ft**	**(238ft)**

1.) Calibrated Airspeed (CAS) is the Indicated Airspeed (IAS) corrected for any errors of the airspeed (pitot-static) system. SD-367 required that this error range from +/- 1 mph at cruise speed to +/- 3 mph throughout the remainder of the normal speed range.
2.) Note the shorter take off distances demonstrated.

The following power rating figures are also from the NATC report. Although that report credits no source for these ratings, they normally would have been based on dynamometer readings by either the contractor, Pratt & Whitney, or a Navy test facility such as the Aeronautical Engineering Laboratory of NAMC. I have added the MAP column for the reasons given in footnote 3:

RATING	**BLOWER**	**RPM**	**HP**	**CRIT ALT[3]**	**MAP**
TO	**Low**	**2,800**	**2100**	**S/L**	**56"**
Military	**Low**	**2,800**	**2100**	**3,300'**	**56"**
Normal	**Low**	**2,600**	**1700**	**8,500'**	**47"**
Military	**High**	**2,800**	**1700**	**16,700'**	**45.3"**
Normal	**High**	**2,600**	**1500**	**18,400'**	**41.5"**

3.) Critical altitude is usually mentioned when performance figures for an airplane are given, but this explanation might prove informative. By definition, the critical altitude for a particular engine/supercharger installation is specific for a given combination of MAP and RPM (and that MAP and RPM combination is really missing from those performance figures). At the critical altitude, the throttle is at the full throttle position and as higher altitudes are attained, the output (HP) of the engine falls off due to the loss of boost (MAP) caused by the decrease in atmospheric pressure. Obviously, a lower MAP could be maintained to some higher altitude, but the engine would no longer be developing the rated HP for that power setting. Generally, the most important critical altitudes are for Military, Normal and Max Cruise power ratings.

The prototypes were equipped with a torquemeter gauge (located where the Master Direction Indicator would be on the production airplanes) used to determine HP. For example, a torquemeter gauge reading of 394 was 3941 ft-lbs (times 10) that equated to 2100 HP @ 2800 RPM, the Military Power Low Blower rating. Therefore MAP, which was not the NATC pilot's primary power setting reference, is omitted from the report. The report also reveals critical altitudes that differ from those previously listed for its power ratings. Whether these differences were due to improved efficiencies of the engine installation, ram air effect or atmospheric conditions isn't as important as the fact that this is what BuNo 44313 demonstrated:

Military power Low Blower (2,100 BHP and 2,800 RPM) SD-367[4]		
Max TAS (mph) @ Sea Level	**312**	**(329)**
Max TAS (mph) @ Critical Altitude	**327/5,000'**	**(340/3,900')**
Military power High Blower (1700 BHP and 2800 RPM)		
Max TAS (mph) @ Critical Altitude	**341/16400'**	**(348/1600')**
Normal power Low Blower (1,700 BHP and 2,600 RPM)		
Max rate of climb at Sea Level	**2,600 fpm**	**(2,800 fpm)**

4.) Could the difference between the TAS figures been due to the increased drag of the conventional cowl flap system that the original exhaust pump had been specified to overcome? The narrowing of that gap in the high blower figures can be partially attributed to the -34W's greater horsepower in high blower than the originally specified -22W model.

Neither Combat Power/War Emergency Power nor Max Cruise were included in the Final Report. Combat Power/War Emergency Power was not needed for any of the stated test purposes while later testing would have developed the range of Max Cruise powers to be included on the Flight Operating Instruction Charts. Those charts would be based on the different airplane configurations (scout, normal bomber, long range bomber, and torpedo bomber, for example) and in 2000 lb weight increments with the power settings depicted being considered as recommended, versus limiting, maximums.

Range and ceiling determinations were not part of the Preliminary Evaluation, therefore the following is from SD-367:

Max Range at rated alt of 18500' (mi)	**1,170**
Average speed[5] for max range (mph)	**190**
Combat Radius (mi)	**356**

Combat radius was defined as:
(a) 20 minutes at warm-up and idling
(b) 1 minute at take-off power
(c) 20 minute rendezvous at 60% normal sea level power and auto lean[6]
(d) Climb to 15000 ft at 60% normal sea level power and auto rich.
(e) Cruise out to target at 15000 ft and 180 kts[7] TAS
(f) Jettison drop tank, dive, drop bomb
(g) 5 minutes combat at 1500 ft at war emer. power
(h) 10 minutes combat at 1500 ft at normal power
(i) Cruise back at 1500 ft at 170 kts TAS & auto lean
(j) 60 minutes at V for max range and auto lean as allowance for rendezvous, landing and reserve.

5.) The term average speed indicates that the cruise-procedure of maintaining one power setting and altitude (18,500') was followed. Using that procedure, as the fuel burned off and the airplane grew lighter its airspeed would increase.

6.) This terminology used for the mixture control indicates that at the time the design specification was written the early-war, AUTO-RICH and AUTO-LEAN system was to be installed. At the same time, however, the RICH - NORMAL system which went on to become the standard for single-piloted airplanes, was under development. The difference in the two systems was in the power setting that opened their carburetor's power enrichment (PE) valve.

7.) Following this conversion of the airplane speed from mph to knots, all factors (airplane, ship and wind) would be in the same unit of measure for use in the pilot's navigation.

Estimated Service Ceiling (altitude which produced a rate of climb of 100 fpm):

BOMBER	**29000 ft**
SCOUT	**32800 FT**

BuNo 44313 with the unmodified wing, demonstrated the following stall speeds:

Configuration	**Power**	**Minimum CAS**
Clean		
G	**Off**	**97.5 mph**
CR	**For Max Range**	**90.0 mph**
Full Flaps, Landing Gear Down		
L	**Off**	**86.0 mph**
PA	**For level flight at 1.15 V_{SL}**	**74.0 mph**

Navy specifications required that the XBTK-1, when configured as its "design specification" (bomber 1000lb bomb, take off gross weight of 14881 lbs) and at its "design gross weight" (14300 lbs as attained at the end of (e) in the Combat Radius definition), be able to meet limit load factors of +7.5 and -3.0 before permanently deforming (popping-rivets or wrinkling-the-wings) any of its metal. For those extreme conditions, when a load greater than the load limit is encountered, an additional "ultimate factor of safety" of +1.4 (for the XBTK-1 but less than the Navy standard of +1.5 perhaps as another concession to "lightness"?) was specified. These limit load factors of +7.5 and -3.0 were standard dive bomber requirements, and were to be demonstrated during future NATC trials. After completing that, the positive limit would then be lowered to +7.0 (as an additional safety factor) and together with the -3.0 limit, serve as the acceleration limits (g units) of the vertical scale of the Operating Flight Strength Diagram where aircraft speed (V) served as the horizontal scale. The resulting plot of airspeeds (Vn) versus acceleration limits (Vg) was valid up to the altitude identified on that plot and enclosed the range of airspeeds and "g"s within which the airplane should be operated, known as it "envelope". Expanding on that, the Operating Flight Strength Diagram would also include Vn-Vg diagrams for higher altitudes with each plot lowering the IAS and g limits, thereby narrowing the airplanes envelope. All Vn-Vg diagrams were specific to the airplane's "design configuration" and "design gross weight". The operational use of different configuration and gross weight combinations would further affect the airplane whose operation was also subject to the limitations placed on the use of its systems.

Our copy of the XBTK-1 Pilot's Handbook, because of its preliminary-status, merely lists the acceleration limits as: +5.0 "g"s to 20,000 ft and +3.8 "g"s for all higher altitudes without listing any negative g limit. The accelerometer used for determining the "g" forces was located below the armament panel. The other Pilot's Handbook limitations were:

FLAPS	**Take-off 30°**	**180 mph**
	Full 45°	**180 mph**
DIVE BRAKES	**Full Open**	**380 mph**
LANDING GEAR	**Hydraulic Extension (2g limit)**	**180 mph**
Vmax (Investigated)		**410 mph**
Cg LIMITS		**22.5% to 27.0% MAC**

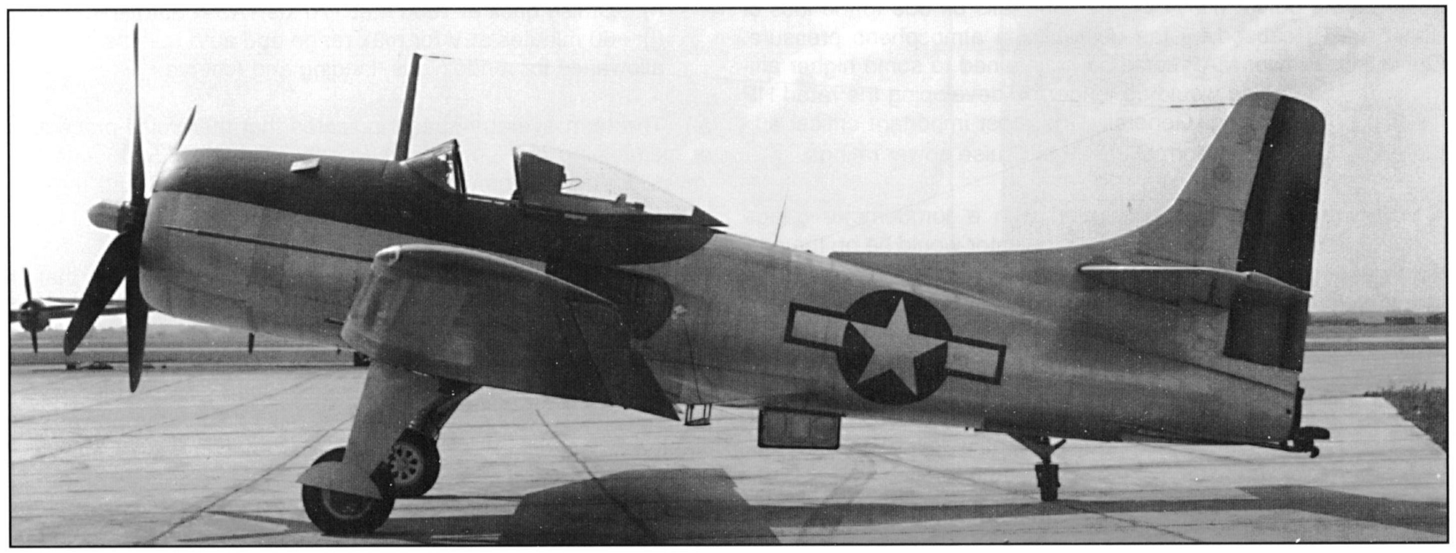
The maximum angular deflections of the control surfaces were changed from SD-367's original values and, as a result of the aerodynamic deficiencies revealed in the Final Report, would have been subject to further modifications:

Rudder	**30° right, 30° left**	**30° right, 30° left**
Rudder trim tab	**15° right, 15° left**	**10° right, 12° left**
Stabilizer	**2° up to 5° down**	**4° up to 3° down**
Elevator	**25° up to 15° down**	**25° up to 15° down**
Aileron	**15° above, 15° below**	**13° above, 14° below**
Aileron tab	**15° above, 15° below**	**13° above, 14° below**
Flap landing	**45° below**	**43° below**
Dive brakes	**73° above, 80° below**	**72° above, 66° below**

Having started this study with a comparison of the XBTK-1's load carrying capabilities and that of the AM and AD, we'll conclude with one of their respective wing and power loadings, all airplanes in their design configuration and at the critical altitude of their Normal Rated Power, High Blower. The XBTK-1 loadings in parenthesis are from SD-367 and offered as an example of the Fleetwings designers' ability to improve on the Navy's design specifications.

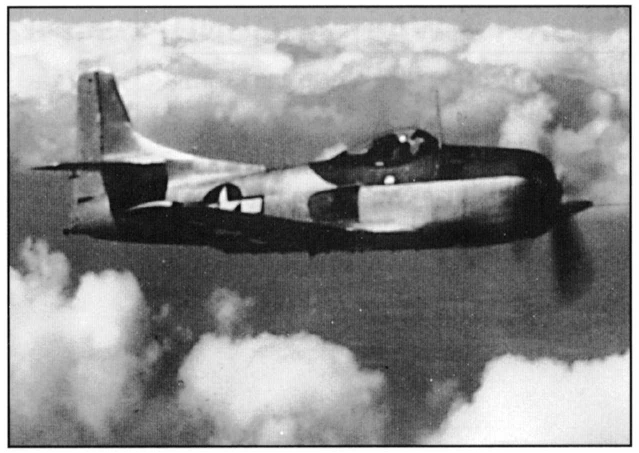
	Design Gross Wt.	**Wing Area (Sq Ft)**	**Wing Load (Lbs/Sq Ft)**	**BHP/Crit Alt (BHP@Crit Alt)**	**Power Load (Lbs/HP)**
XBTK-1	**14300**	**380**	**37.6 (39.1)**	**1500@18400**	**9.5 (10.3)**
AD	**15600**	**400**	**39.0**	**1900@17200**	**8.2**
AM	**19450**	**496**	**39.2**	**2250@13250**	**8.6**

Below, one of the few photos existing of XTBK-1, BuNo 44314. Note the small cowl flap that has been added forward of the canopy. Rudder is believed to be blue. (NACA via Hal Andrews)



STORES CAPABILITY COMPARISON

	XBTK-1	**XBTM-1**	**XBT2D-1**
Fuselage centerline station:			
Max weight of bombs (lbs)	2,000	2,300	2,300
Number of center wing bomb racks	2	2	2
Max weight on each wing rack (lbs)	1,000	2,300	2,300
Zero length rocket launcher stations	8	12	12
Number of 500lb bombs that could be carried at rocket launcher stations	0	6	8
Max total weight of bomb load (lbs)	4,000	9,900	10,900
20mm guns (200rpg)	2	4	4
Full internal fuel capacity (gals)	275	510	380



MISSION WEIGHTS

		CVE: CLOSE AIR SUPPORT PERCEIVED CONFIGURATIONS		**CVL: FAST CARRIER TASK FORCE PERCEIVED CONFIGURATIONS**	
	DESIGN CONFIGURATION BOMBER	**ROCKETS & GUN PODS**	**ROCKETS & NAPALM**	**TORPEDO**	**OVERLOAD BOMBER**
Weight Empty	10,253	10,253	10,253	10,253	10,253
Residual Fuel (2 gal)[1]	12	12	12	12	12
Residual Oil (6 gal)	45	45	45	45	45
Guns (2)	254	254	254	254	254
Rocket Launchers	0	(8) 145	145	0	0
Canteen & Water	8	8	8	8	8
Oxygen Equipment	18	18	18	18	18
Navigation Equipment	5	5	5	5	5
Miscellaneous[2]	78	78	78	78	78
	---------	---------	---------	---------	---------
Basic Weight	10,673	10,818	10,818	10,673	10,673
275 gallons fuel	1,650	1,100 [3]	1,100 [3]	1,650	1,650
21 gallons oil	158	105 [3]	105 [3]	158	158
	---------	---------	---------	---------	---------
Weight Sub-total	12,481	12,023	12,023	12,481	12,481
Crew[4]	200	200	200	200	200
ADI Fluid (10 mins Combat Power)	100	100	100	100	100
Ammunition (200 rpg)	264	264	264	264	264
5.0 inch Aircraft Rocket	0	(8) 640	(8) 640	0	0
Fuselage Bomb Rack:					
Torpedo	0	0	0	(1) 2,200	0
2,000 lb bomb	0	0	0	0	(1) 2,000
1,000 lb bomb	1,000	0	0	0	0
Napalm (100 gal droppable fuel tank)[5]	0	(1) 692	(1) 692	0	0
Wing Bomb Racks:					
1,000 lb bombs	0	0	0	0	(2) 2,000
Gun Pods[6]	0	(2) 912	0	0	0
Napalm (100 gal droppable fuel tank)[5]	0	0	(2) 1,384	0	0
Radar	146	0	0	146	0
100 gallons Fuel (droppable tank)[7]	690	0	0	690	0
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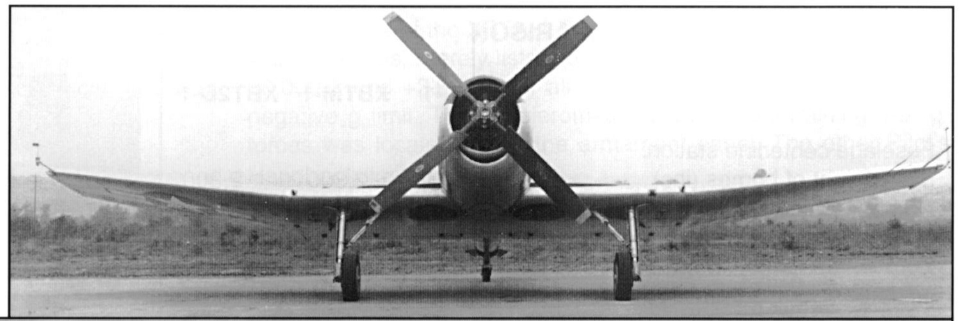
Gross Weight at Take Off (T.O.)	14,881	14,831	15,303	16,081	17,045

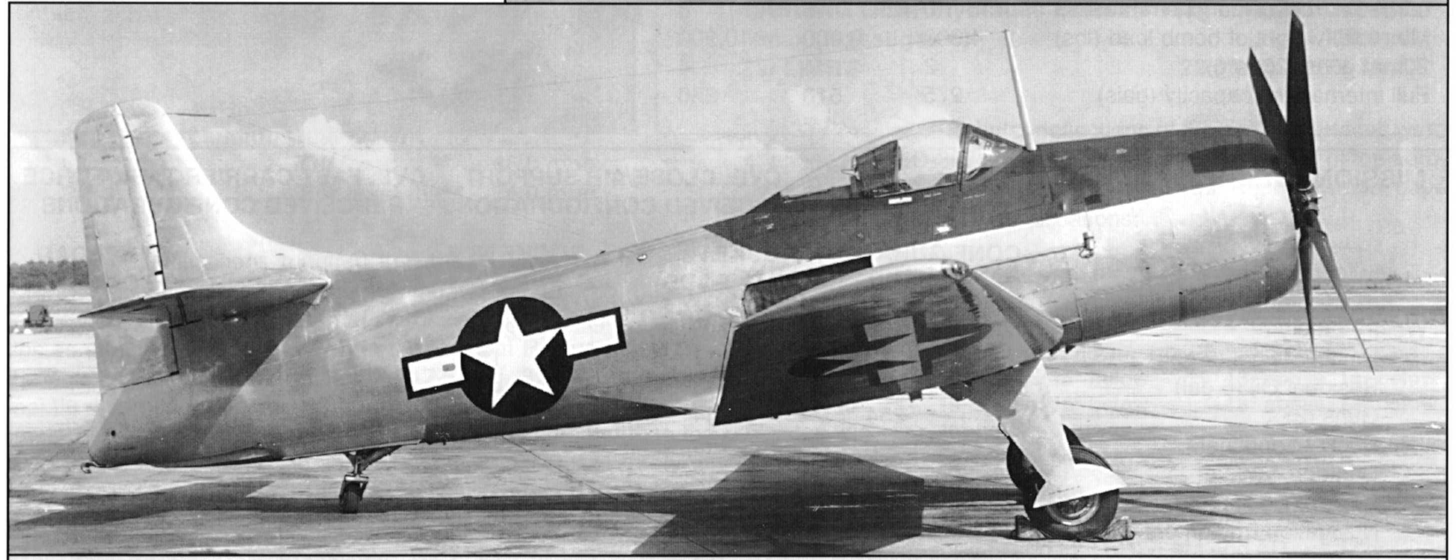
Notes:
Handbook Limitations: Total weight of external stores not to exceed 4,890 pounds.

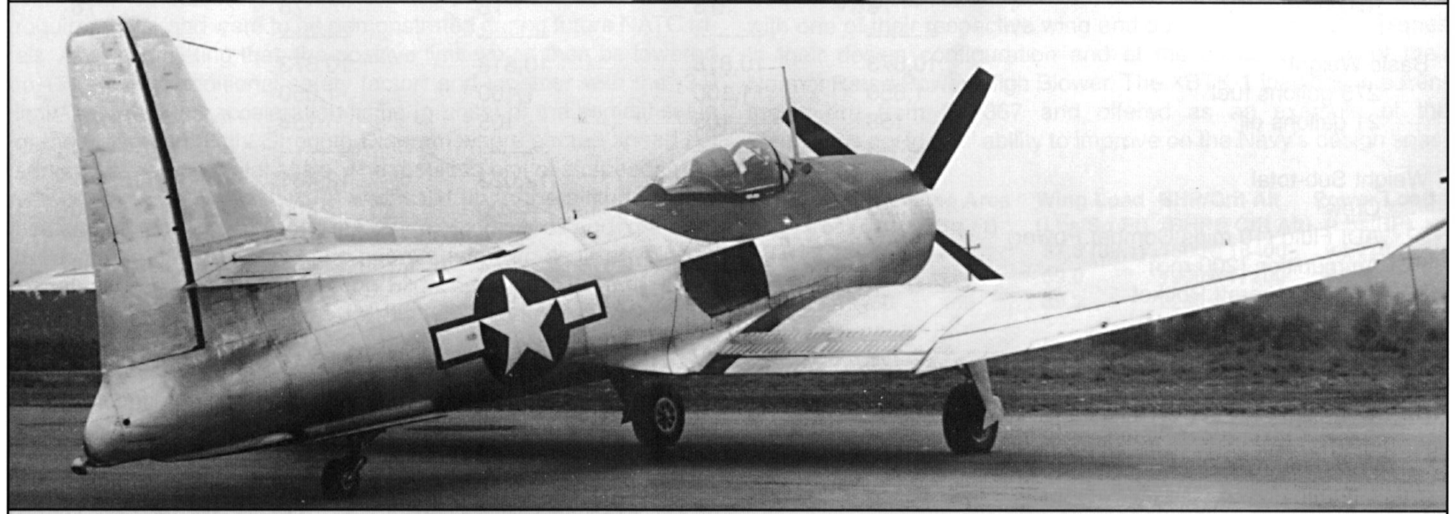
1.) Residual fuel and oil is fluid that is trapped in the respective system and unavailable for use.
2.) Miscellaneous includes, arresting gear, gun camera, anti-icing fluid, etc.
3.) Fuel and oil quantity is 2/3 the internal capacity, a standard way to lighten the aircraft when the mission was short-ranged. ADI fluid could have been deleted if there was no enemy air opposition.
4.) Crew weight is the pilot with his parachute and life jacket.
5.) Based on 6.2 lbs/gal as weight of napalm and 72 lbs for the weight of the 100 gallon droppable tank.
6.) Each gun pod contained two .50 cal guns with 350 rounds of ammunition per gun.
7.) Handbook weight for 100 gallons of fuel and the droppable tank which includes its fuel supply line, vent and filter.

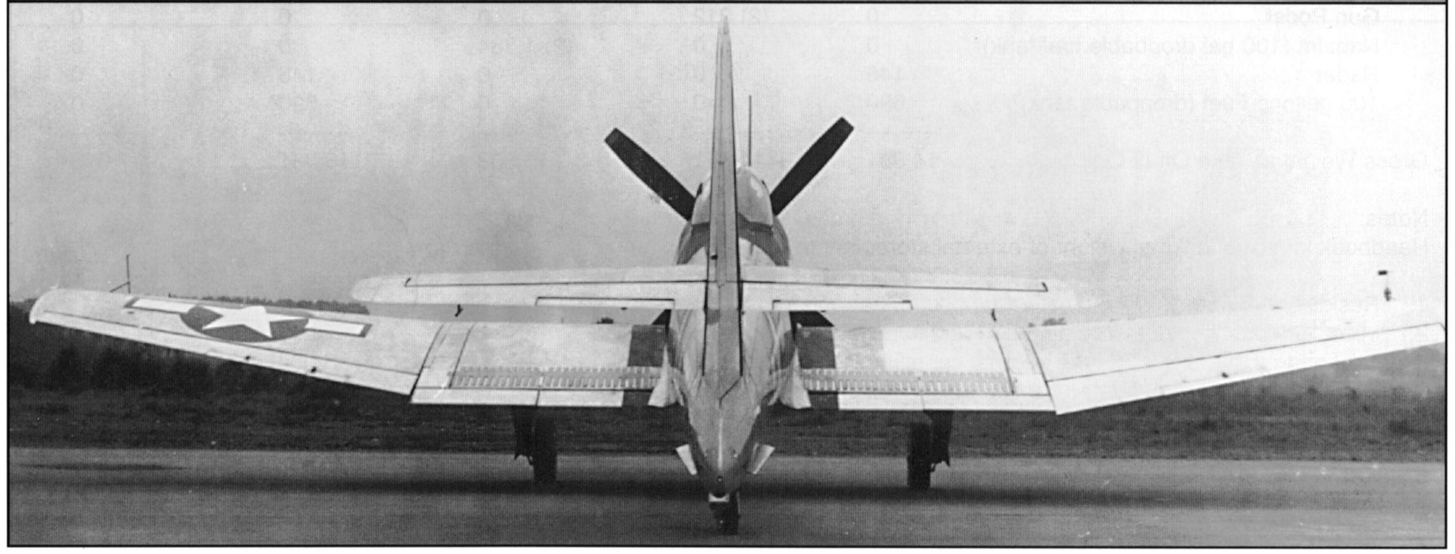
XTBK-1 WALKAROUND

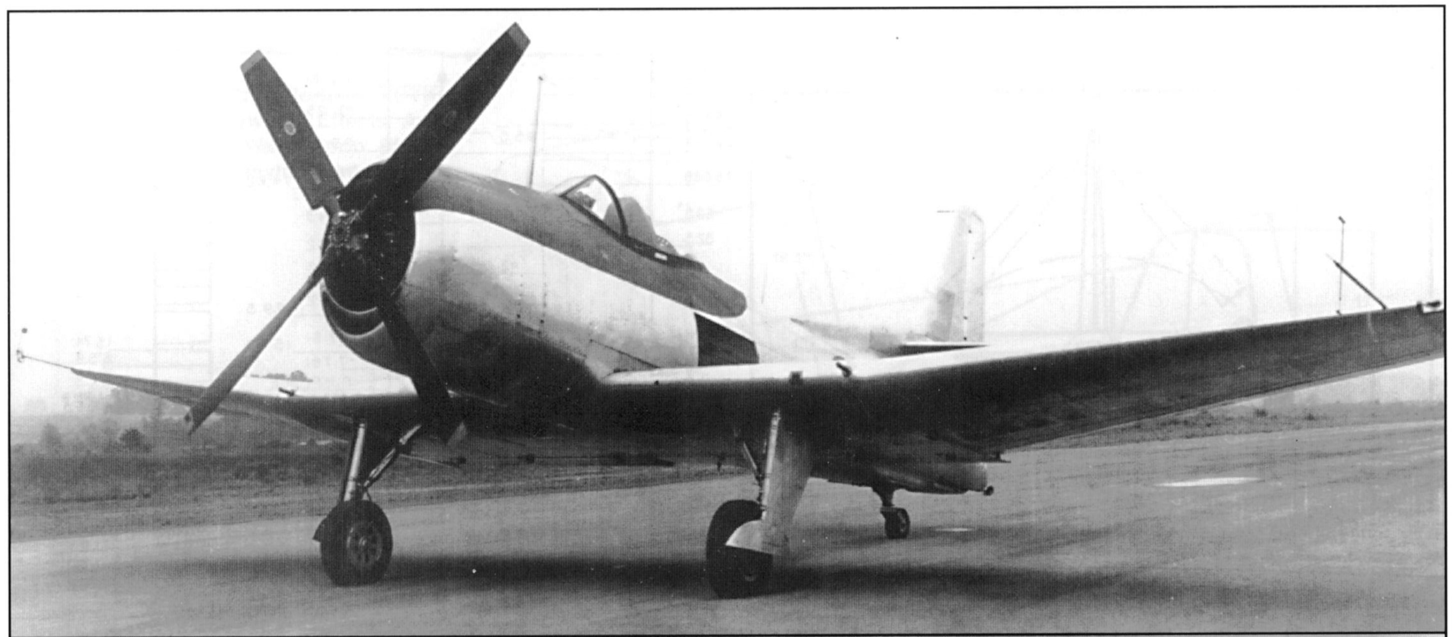
Walkaround of XBTK-1, BuNo 44313, on 8 August 1945. Photo below, USN via Hal Andrews, all others National Archives. The aircraft was overall natural metal with large flat black anti-glare panel. The exhaust area was treated with heat resistant black paint to protect the metal from corrosion.

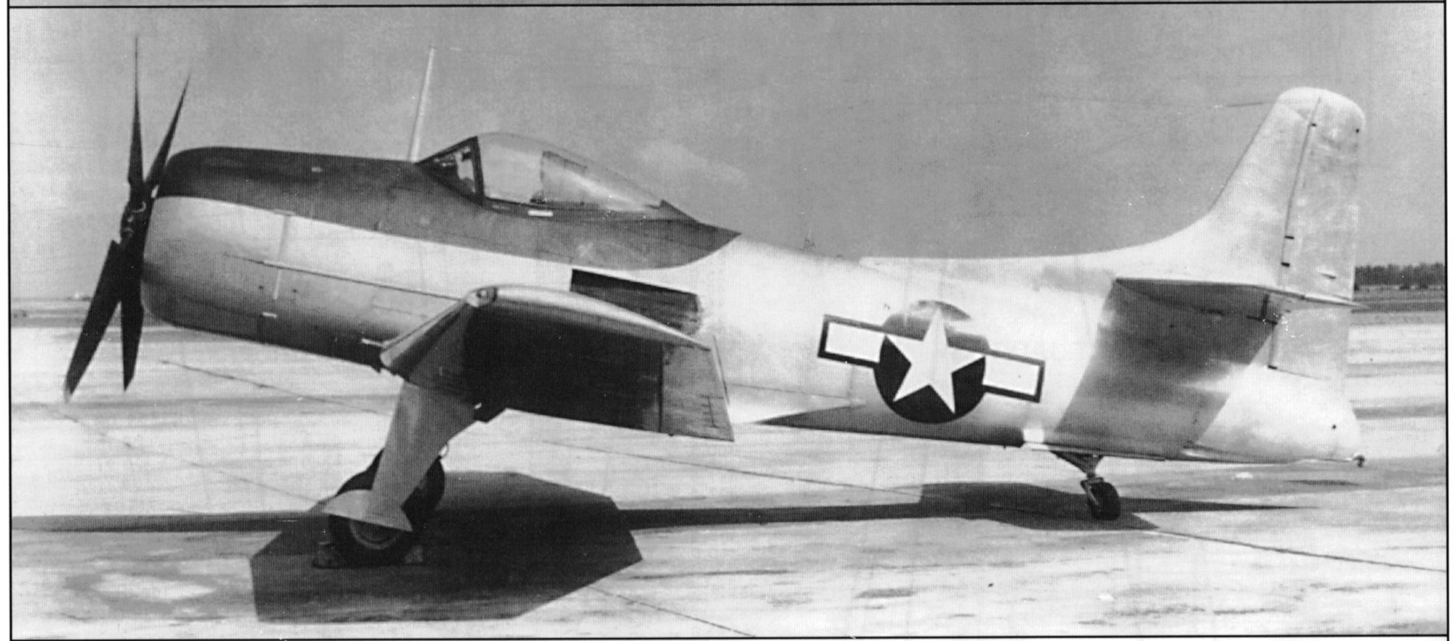


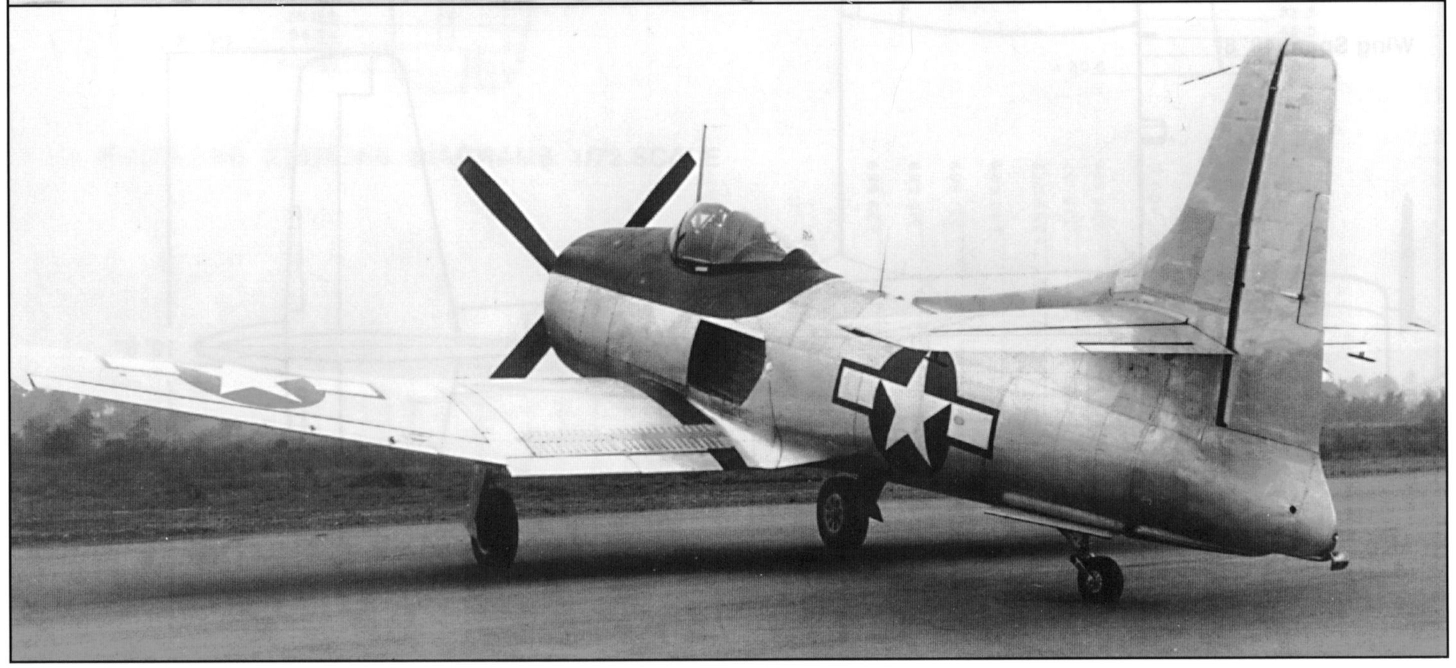


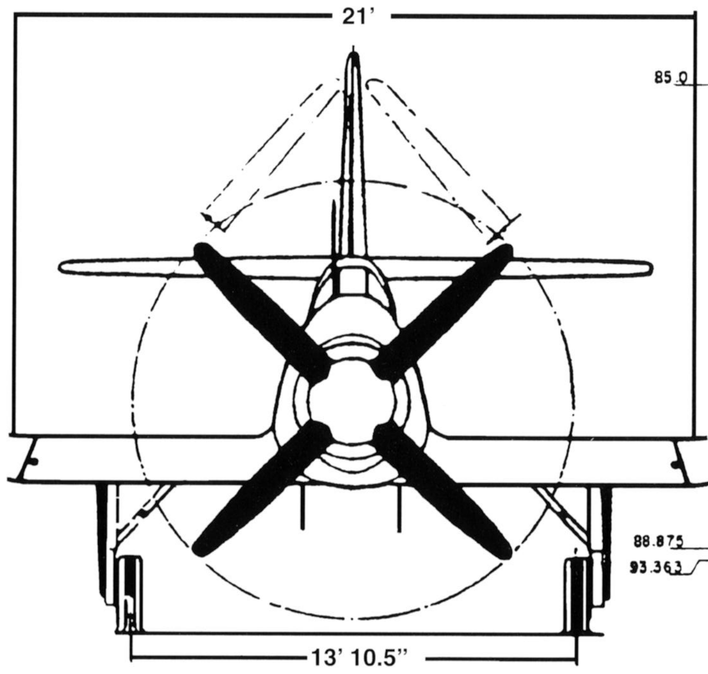


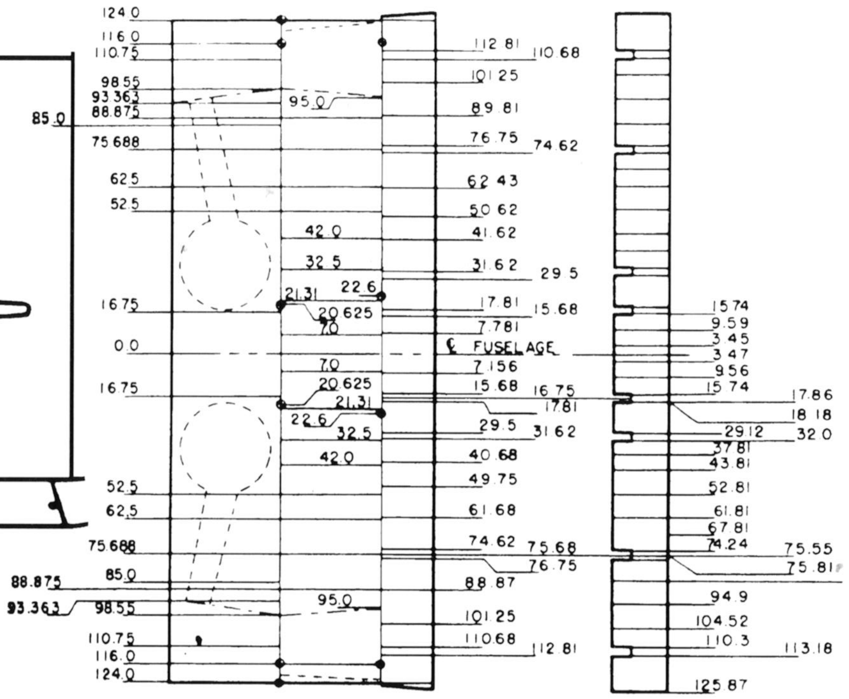




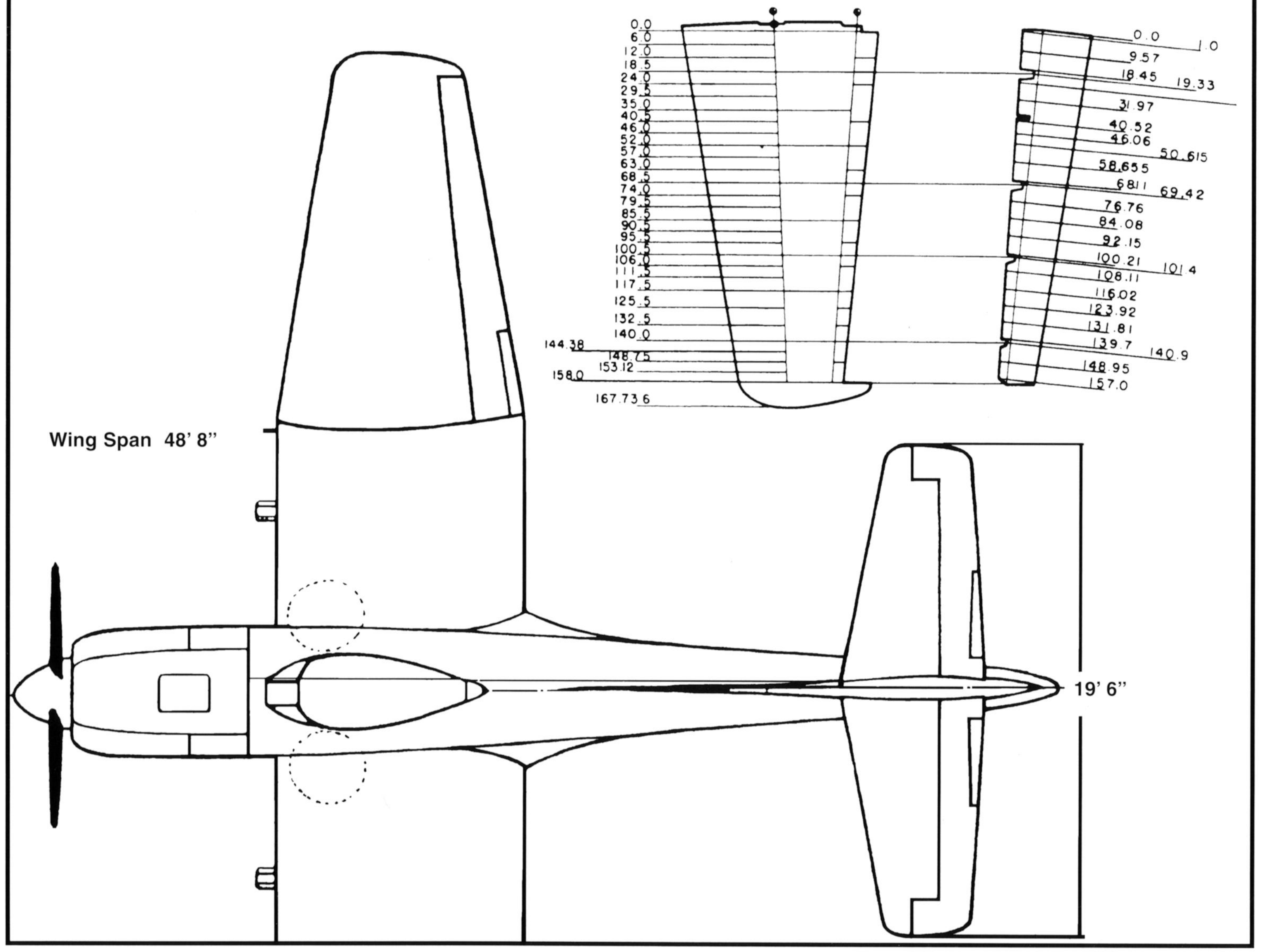




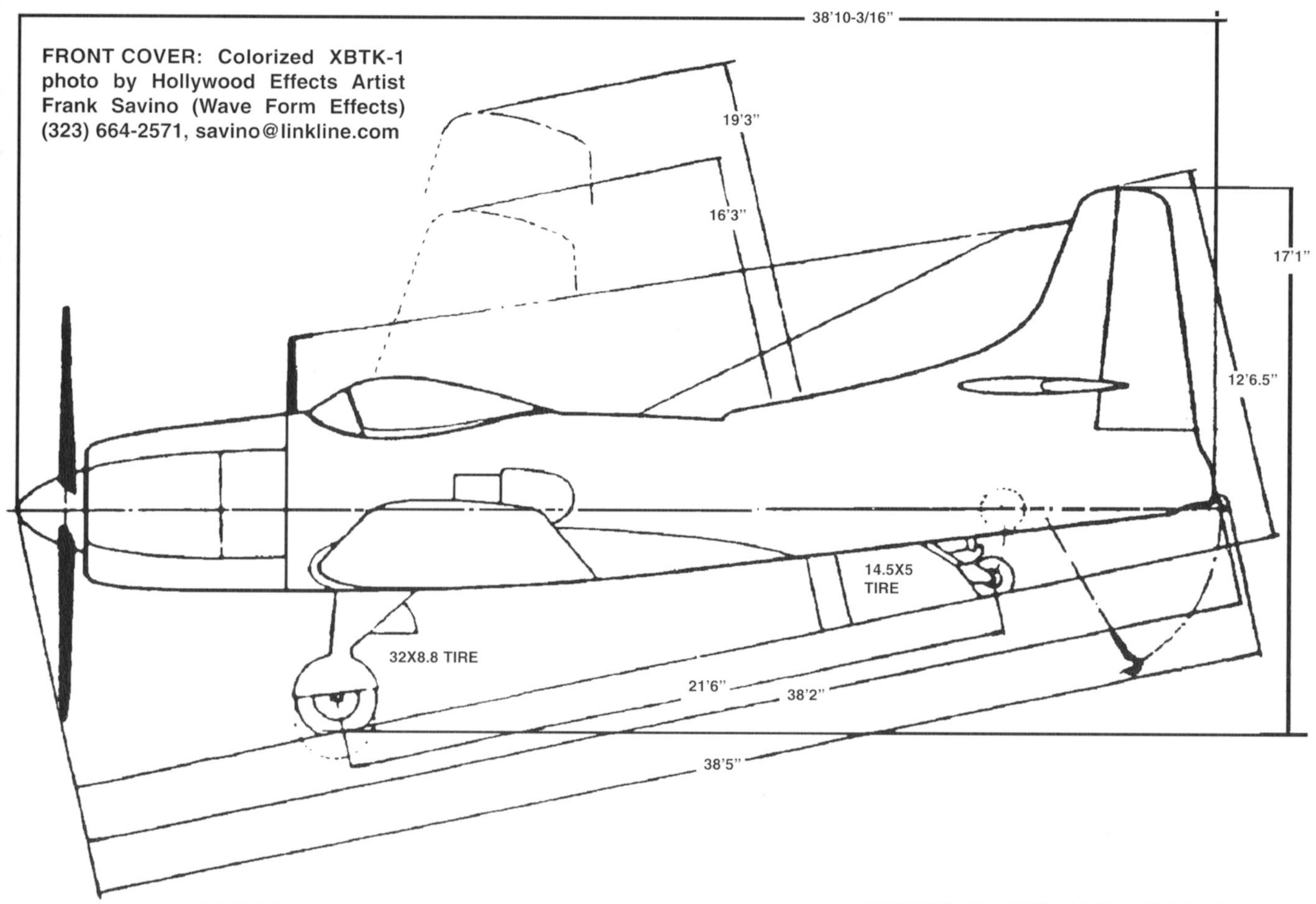




WING STATIONS 1/72 SCALE

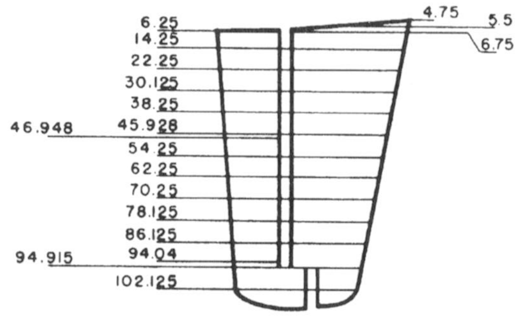


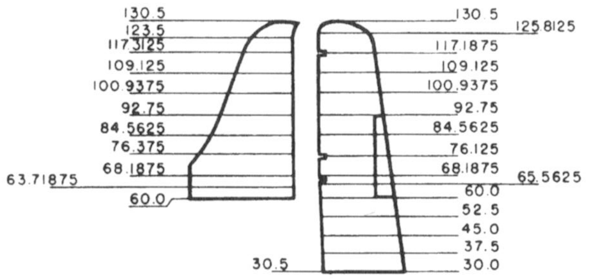
FRONT COVER: Colorized XBTK-1 photo by Hollywood Effects Artist Frank Savino (Wave Form Effects) (323) 664-2571, savino@linkline.com



HORIZONTAL STABILIZER

VERTICAL TAIL AND RUDDER





FUSELAGE STATIONS DIAGRAMS 1/72 SCALE